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SEPTEMBER 1925—THIRTY-SECOND YEAR

MACHINERY

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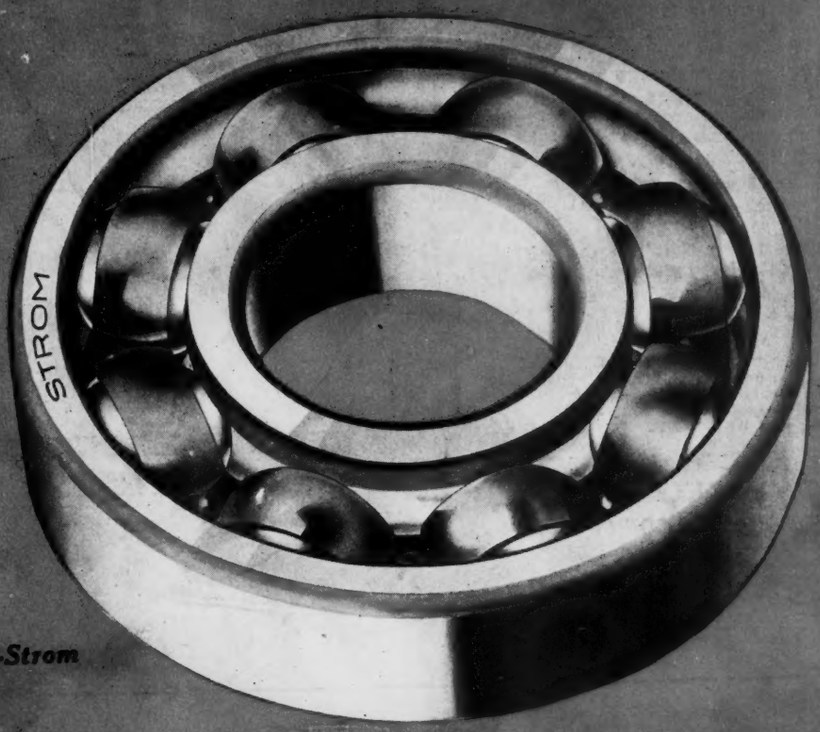

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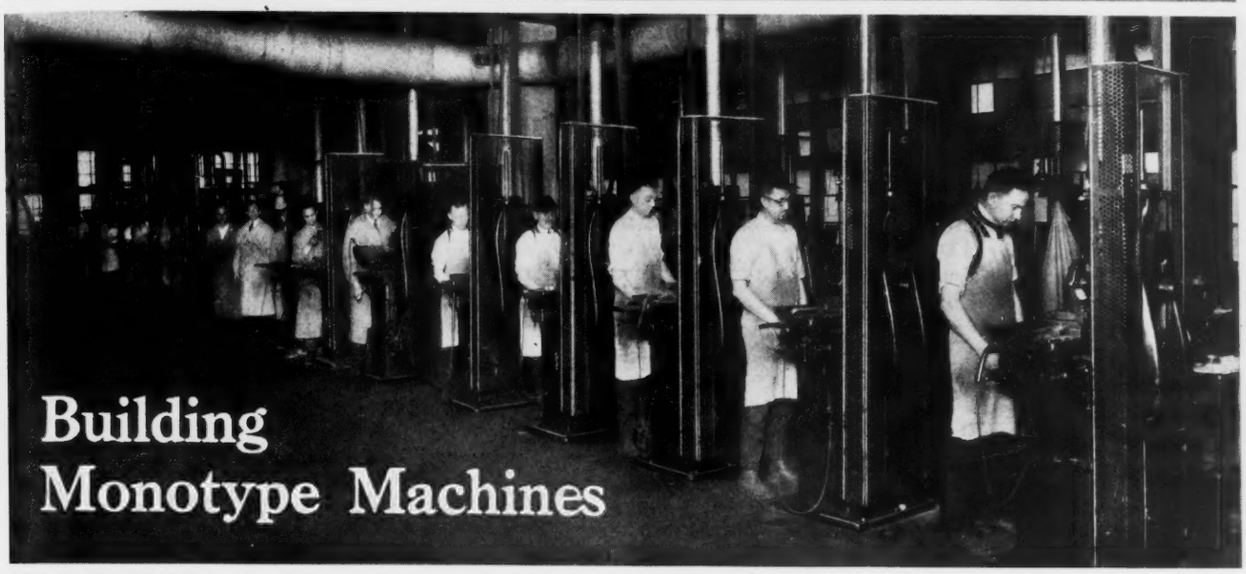


Building Monotype Machines

Unusual Methods Used in Producing a Line of Machines Well Known in the Printing Field

By CHARLES O. HERB

IN the plant of the Lanston Monotype Machine Co., Philadelphia, Pa., there is a pantograph type of machine by means of which the entire Lord's Prayer and the name and address of the company has been engraved on a small steel punch only 1/6 inch square. The letters are but 0.006 inch high. This punch has been used to impress its inscription into the end of brass matrices which in turn are employed to reproduce the Lord's Prayer on lead type made in the regular monotype casting machine. Every letter on this type stands out so clear under a magnifying glass that the inscription can be easily read.

While these type castings serve no practical purpose, they emphasize the accuracy of a machine that is continuously used to make punches for reproducing matrices supplied in the monotype machines. The engraving of these punches is very interesting, but no more so than any number of operations performed in the same plant. Such of these operations as are based on principles that could readily be applied in other shops will be described in this article.

Using Ten Broaches to Finish an Odd-shaped Hole

The ten broaches shown in the case in Fig. 1 are used to finish an opening in a machine-steel type carrier to the shape illustrated at *K*, Fig. 2. The section through which this opening extends varies from 3/4 to 1 1/8 inches in thickness, and the cutting portions of the broaches are about 15 inches long. Before broaching, a 23/32-inch hole is drilled at a point close to the center of the finished opening, as shown at *A*. The broach at the bottom of the case in Fig. 1 is then used to produce a hole of the form shown at *B*, Fig. 2, surface *a* being broached to the finished height, and slot *b* started. This broach removes about 0.204 inch of stock from each corner and cuts to a width of 0.727 inch.

The second broach from the bottom of the case increases the depth of slot *b* 0.092 inch, as shown at *C*; the third removes 0.093 inch of stock from the same surface, as illustrated at *D*; and the fourth, 0.085 inch of stock as shown at *E*. In the second, third, and fourth steps, the broach is supported by bearing against surface *a*. The fifth broach is used to cut slot *c*, as shown at *F*, to a width of 0.146 inch and a depth of 1/8 inch, the broach being supported and guided by slot *b*. Metal is removed from sides *d* and *e*, as shown at *G*, by the sixth broach. The teeth of this broach are offset from the center and cut more stock from side *e* than from the opposite one. This broach also rests on surface *a* and on the bottom of slot *b*, and is guided by the walls of the slot.

The seventh broach completes side *d* and also removes stock from side *e*, bringing the hole to the shape illustrated at *H*, while the eight broach finishes side *e* to size, as shown at *I*. These two broaches are also guided by surface *a* and slot *b*. Slots *f* and *g* are finished, as shown at *J*, to a depth of 0.075 inch by the ninth broach, which is supported and guided by slot *b* and surfaces *h* of the main opening. The tenth and last broach is similarly used to finish slots *f* and *g* to a depth of 5/32 inch, as shown at *K*.

Broaching Fifteen Slots Simultaneously in the Matrix Case and Milling the Matrix Bars

The matrices used in producing the characters on the type made in the monotype machines are held in the case shown at *A*, Fig. 5, by means of fifteen metal strips or "combs" of tool steel, which extend from the slots in side *B* to those in side *C*. Teeth are so milled on these strips as to give 225 square openings in the case when the combs are assembled and the matrices are fitted into these square holes. The matrix case, with the combs in place, resembles a bee's honeycomb.

There are sixteen slots in each side *B* and *C* of the matrix case. These are produced by means of pull-broach *D*, on the upper side of which there are six units of sixteen inserted blades each. The blades are 2 inches long, and they broach slots 0.050 inch wide and 0.086 inch deep. After the slots have been produced in one side of the case while the latter is held against the machine as illustrated at *E*, the case is turned end for end for broaching the slots in the opposite side. Prior to this operation, a broach similar to

G.E.F.

that shown, but equipped with cutting teeth at each of the four corners, is used to square up the inside corners of the case, which are left slightly rounded by a previous milling operation on the inside surfaces of the case.

The matrix bars or combs are milled two at a time from pieces of stock 0.200 inch square by means of the tooling shown in Fig. 3. Sufficient stock for two bars is gripped by means of hinged jaws in fixture *A*, the excess stock projecting from the fixture, as indicated at *B*. In operation, the stock pieces are pushed into the fixture until they strike a stop, and then the jaws are locked in place by operating the handle on the left-hand end of the fixture. When the table of the machine is fed toward cutters *C*, the fifteen tooth spaces are milled in the combs, and the ends of the combs are finished to length. There are fifteen cutters for producing the tooth spaces, and one on each end for truing the combs to length. The tooth spaces are milled 0.152 inch wide and deep with a tooth 0.048 inch wide between them. The limits on the width and depth is plus or minus 0.0005 inch.

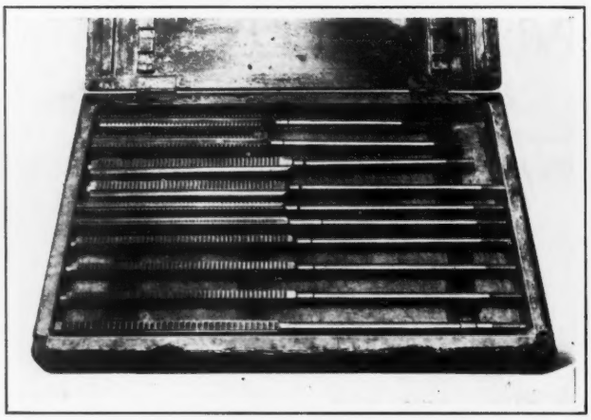


Fig. 1. Set of Ten Broaches used to finish One Odd-shaped Hole

Drilling 225 Holes at Center Distances of 0.200 Inch

In the monotype casting machines, a carbon steel cover plate, such as shown at *A*, Fig. 6, is mounted over the matrix case. The holes in this plate are drilled to center distances of 0.200 inch each way, within plus or minus limits of 0.0005 inch, which corresponds to the center distances between the tooth spaces of the matrix case. After drilling, the holes are reamed to a diameter of 0.180 inch. It is obviously impossible to drill or ream two adjacent holes in this plate at the same time, because of the close center distances; hence, two groups of nine spindles each are used for the operations. The fixture is fitted with a carriage *B* which can be shifted transversely and longitudinally relative to the spindle head, so as to permit different holes to be drilled or reamed at each movement of the spindle head. Twenty-five passes of the head are required to perform the drilling, and as many traverses for reaming the holes.

At the beginning of the drilling operation, carriage *B* is brought into the position shown, and the cover plate is laid on block *C* into which 225 holes are drilled to permit feeding the drills or reamers through the work. The cover plate is laid in place with one slot engaging a key at the rear of the fixture, and then handle *D* is tightened to engage another key in the front slot. These keys prevent shifting of the work in the operation. On the left-hand side of the jig table, there is a rack that permits locking the jig in five different positions by means of a pin, and there is a similar arrangement on the front side of the table. This gives a total of twenty-five different table positions, which is sufficient for drilling all the holes.

When the drilling is completed, carriage *B* is simply moved to the left-hand position under the group of reamers, and the reaming is performed in the same manner as the drilling. Blocks *E* and *F* are graduated in accordance with the racks used in setting the jig table in the different positions, so that the operator can readily tell when the fixture has been moved approximately into position for locking. For an operation, the table is raised close to bushing plate *G*. Coolant is generously supplied to all drills and reamers through pipes *H* and *J*.

Milling Plate Cams in Pairs

In the monotype casting machines, two case-iron plate cams, such as shown at A and B, Fig. 8, are used together, and it has been found desirable to mill each pair at the same time, as illustrated. For the operation, the cams are mounted on spindles located at the same center distance as the shafts on which the cams are mounted in the machines. Cutter *C* is simply entered between the cams and finishes them as they are revolved on their spindles and rocked back and forth relative to the cutter. The cutter is rapidly advanced to a position close to the cams by manipulating a lever at the front of the machine, and then a second lever is operated to feed the cutter slowly into position between the cams, where it remains until the latter

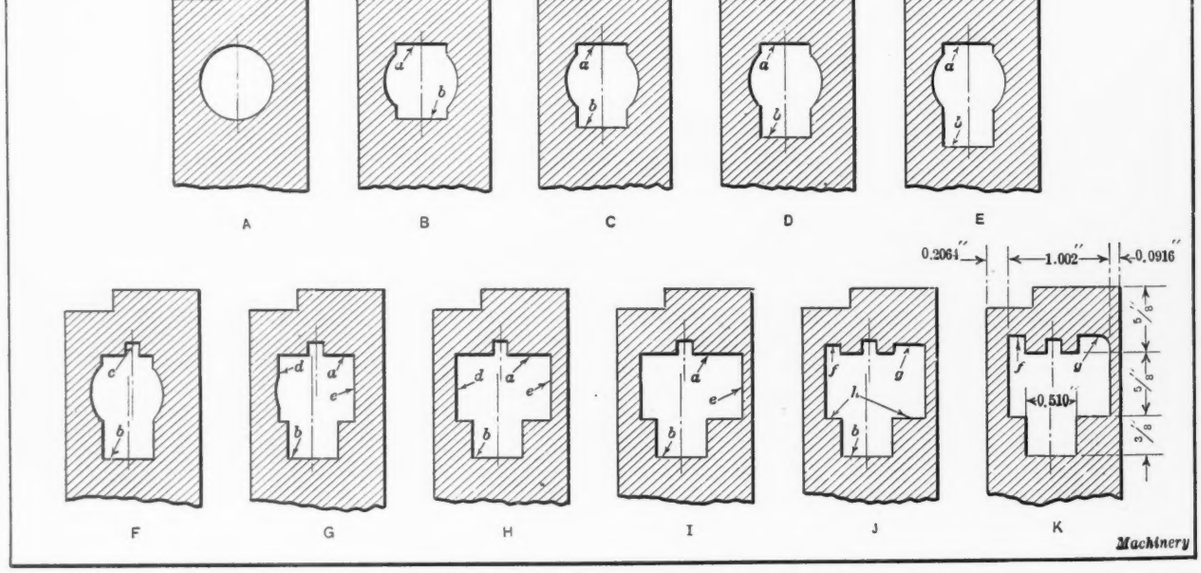


Fig. 2. Successive Steps in finishing the Odd-shaped Hole with Broaches illustrated in Fig. 1

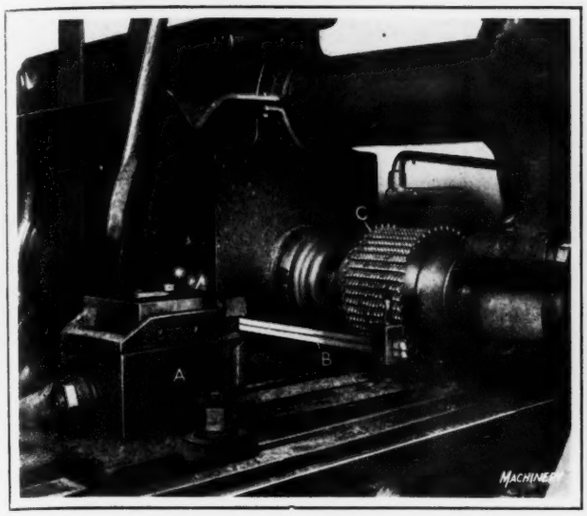


Fig. 3. Seventeen Cutters being used together to produce Fifteen Slots simultaneously and to cut the Stock to Length

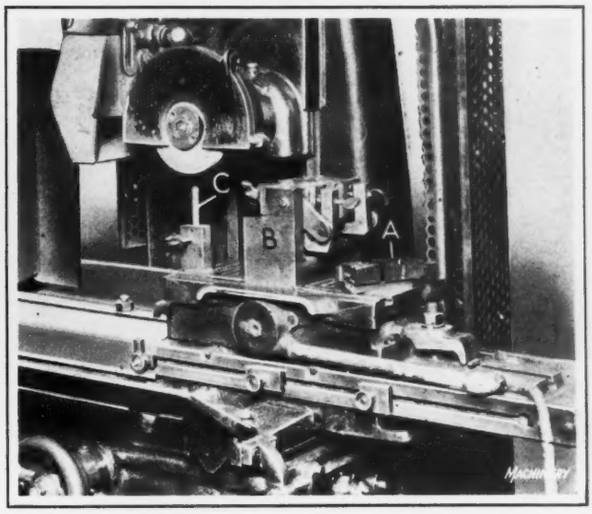


Fig. 4. Typical Grinding Operation performed in the Large Department shown in the Heading Illustration

have been finished around the entire periphery. A pilot on the cutter-arbor enters a bushing on the opposite side of the cams, to steady the cutter.

To insure that the center distance between the cams will not change as they are rocked back and forth, the work-spindles are mounted in one head. This head is swiveled on a horizontal shaft by means of two formers on the rear end of the cam spindles, which are of the same size and shape as the cams. Between these formers is a roller of the same diameter as cutter *C*, and as this roller is prevented from moving sidewise, the rotation of the formers causes them to rock the work-head to suit the outline of the cams. Rough and finish cuts are taken. When the cams are removed from the machine, they are suitably marked to insure that those finished together will be used in the same machine. This cam milling machine was developed and built by the company.

Die-Set that Meets Over 3000 Conditions

Fig. 9 shows a sectional set of dies that can be used to make more than 3000 styles of the type bar illustrated at *A*. Two hundred and eighty-six of these bars are used in each monotype keyboard, and each of these bars differs with respect to the location of the two lugs on each side. These lugs are spaced at various center distances along the bar, and in a wide range of different positions. Gage *B* clearly illustrates the large combination of lugs that may be obtained. It must be remembered that there are only two lugs on each side of any bar.

There are twenty block sections *C* along the front of the punch and die units, and twelve wider blocks along the rear. Two of the front punch and die-blocks and two of the rear blocks are notched to produce the lugs on the work. These blocks are interchangeable with all others of the same size, and so it is an easy matter to insert the notched blocks in any required positions. It is the practice to run through a large quantity of bars each time the blocks are reset. A narrow steel strip, which is spring-supported, runs the length of the die between the front and rear blocks to eject the blanked bars.

The Matrix Punch Engraving Machine

The engraving machine referred to at the beginning of the article is shown in Fig. 11, cutting the letter "W" on a punch. The punch is held vertically in block *A*, and is slid in any direction in a horizontal plane over an engraving tool attached to a spindle driven by pulley *B*. Movement of the punch is accomplished through mechanisms *C* and *D*, as washer *E* is guided by hand along the contour of a large model of the letter being engraved. At the beginning of the

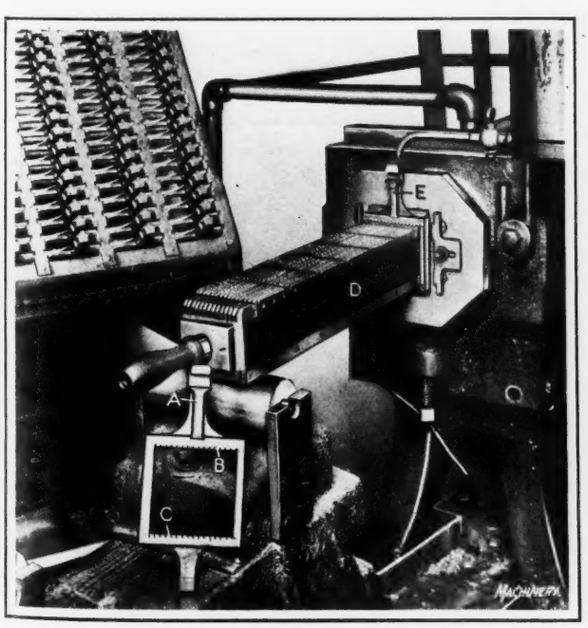


Fig. 5. Broach employed to produce simultaneously Sixteen Narrow Slots in the Matrix Case

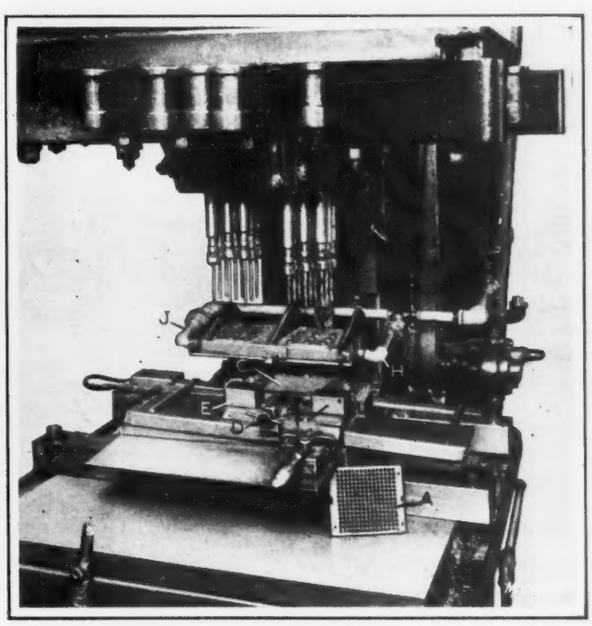


Fig. 6. Fixture by Means of which 225 Holes are drilled and reamed to Center Distances of 0.200 Inch

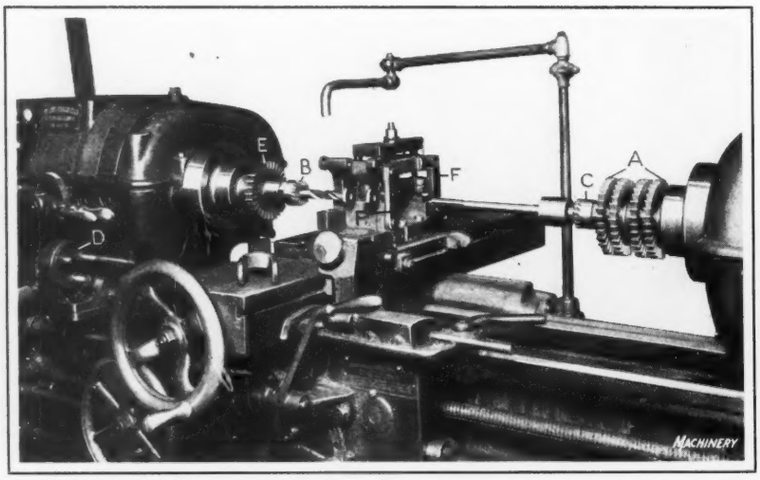


Fig. 7. Double-head Lathe set up for performing Thirteen Drilling, Milling, and Reaming Operations on a Lever

operation, a large-sized washer, such as illustrated, is used, but with each successive cut, smaller washers are used until the character has been cut on the punch. The different cutters are quickly interchanged. The final tool is usually ground to a diameter of 0.005 inch at the point. The model illustrated is 5 3/4 inches high, and is being used to engrave a letter 9/16 inch high, reductions up to 40 to 1 being obtainable through mechanisms *C* and *D*. In engraving the Lord's Prayer on the punch previously mentioned, the model of the prayer was 2 1/2 inches square, and the final tool was ground to a needle point.

Making the models for this machine constitutes an interesting process. The letter to be engraved is first drawn to a large scale on paper, and then this paper is used as a model in the pantograph machine to reproduce the letter to a smaller scale on a wax-coated copper plate. After the wax has been properly routed out, copper is deposited in the openings by the electrolytic process. The plate is then smoothed up by means of hand tools, after which it is ready for use as a model in engraving the punches.

Cutting Costs with a Double-head Lathe

Several styles of levers used on monotype machines are milled, drilled, and reamed complete in the double-head lathe illustrated in Fig. 7. It is, of course, necessary to change the fixture and the tools to suit the different levers. In the job shown, the lever has a yoke at both ends and a central bearing. The first step consists of moving the work-carriage toward the left to drill holes through the yoke arms that project toward the front of the machine, after which the carriage is moved to the right to run a flat drill, held in the right-hand spindle, through the holes just rough-drilled. The carriage is then moved further to the right, with the work fixture at the rear of the cross-slide, to bring the work in line with the four milling cutters *A*, after which the work is fed forward to mill all four bearings of the front yoke at one time.

The carriage is next returned to a position close to the left-hand spindle, and the work fixture is advanced to bring the middle lever bearing in line with this spindle. Then the carriage is fed successively to the left and to the right to rough- and finish-drill a hole through the middle bearing. The drills in the two spindles are next removed, and the faces of the central bearing of the lever milled by feeding the lever first against cutter *B* and then against cutter *C*.

Next, holes are drilled through the rear yoke bearings, after the drills have been re-entered into the sockets of cutters *B* and *C*, and then the inside faces of the rear yoke arms are milled by cutter *E*. Finally, a reamer is mounted in the right-hand spindle, as shown, and all holes in the

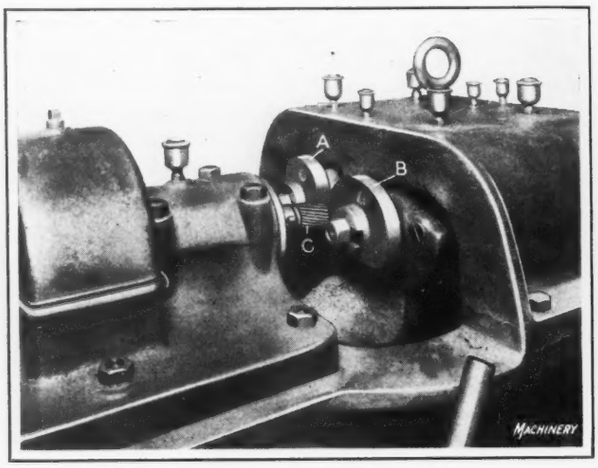


Fig. 8. Special Machine developed for finishing Mating Cams

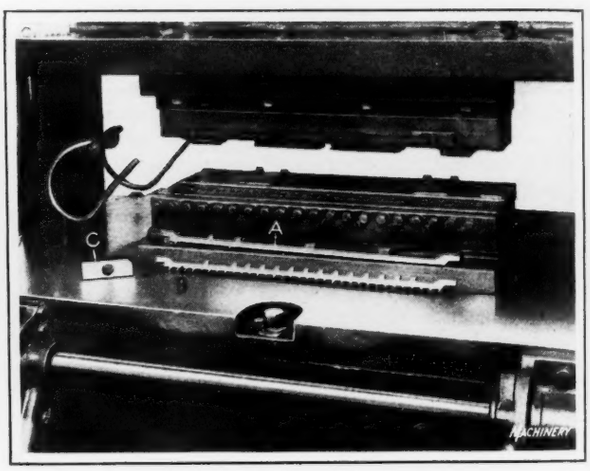


Fig. 9. Punch and Die made up with Interchangeable Blocks

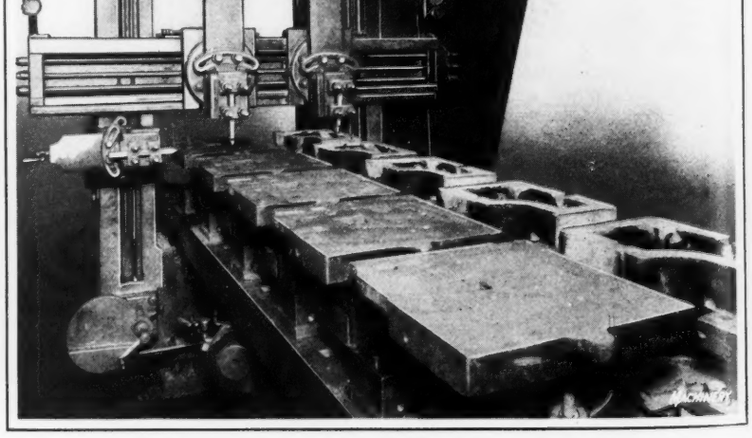


Fig. 10. Planing Ten Castings at One Time by the Use of Two Rail-heads and Two Side-heads

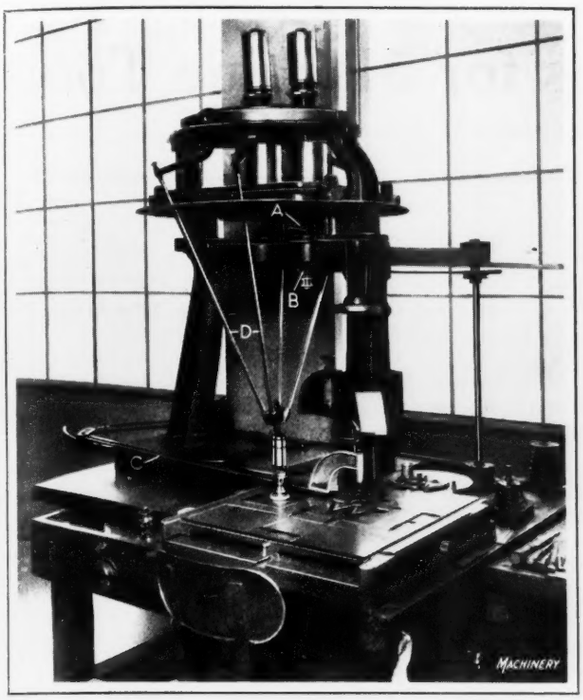


Fig. 11. Pantograph Type of Machine used to engrave Letters to Type Size

lever are finish-reamed. The holes in the yokes and bearing are of different size, but it is an easy matter to substitute the necessary drills and reamers. Stops in unit *D* come in contact with a rod fastened to the carriage, to locate the work properly longitudinally for the milling cuts taken by the tools on the left-hand head, and a similar unit is supplied for use with the tools on the right-hand head. Means are also provided on the cross-slide for locating the work properly transversely for the drilling and reaming steps. Latches *F* are swung down for changing the work in the fixture.

Grinding and Planing Operations

Many flat pieces used in the monotype machines must be ground and lapped to size within plus or minus 0.0001 inch. These parts are finished in the department shown in the heading illustration, in which there are forty-five surface grinders. A typical operation consists of grinding the three mold parts shown assembled at *A* in Fig. 4. The over-all height of these pieces, when assembled, and the straightness of their surfaces must be within the limits of accuracy mentioned, and in addition, all corners must be sharp, even a slight roundness not being permitted. The three pieces are held disassembled in fixture *B*, which is carried back and forth beneath the grinding wheel by a magnetic chuck. Rod *C* contains a diamond for truing the wheel. The parts seat on hardened blocks in the fixture, and are locked in place by equalizing clamps.

Fig. 10 illustrates the procedure followed in planing the top and bottom of a comparatively heavy casting. Five castings are mounted in a row on the planer table, with the top uppermost as shown at the left, and five more beside these with the bottom uppermost. The method followed is first to plane the bottom of the castings, and then the top; hence, in starting a group of castings through this operation, only five are placed on the table. A cut is taken straight across both the tops and the bottoms, and at the same time cuts are taken on one side of each row of castings by means of two side-heads. It is necessary to shift the side-head tools down and in to reach the different surfaces they finish.

* * *

The steel industry employs over 600,000 people, and produces annually over $1,600,000,000 worth of material.

SELLING MACHINERY ABROAD ON CREDIT

Investigations made by the Bureau of Foreign and Domestic Commerce suggest that, generally speaking, American manufacturers should demand payment on exported machinery before the equipment leaves the United States. This rule will probably be found entirely satisfactory 90 per cent of the time, and 90 per cent of our machinery manufacturers should find this method entirely satisfactory for all of their business.

No machinery manufacturer should consent to export machinery on any other basis unless he has a well-developed export department, which is fully equipped and fully competent to handle foreign business of this character. Under conditions existing in various foreign countries, these credits have sometimes been subject to serious abuses, and the process of collecting for such items in case of difficulty are complicated and intricate and call for very careful work. Experience also indicates that where credits are extended, foreign machinery manufacturers frequently arrange to have the transaction guaranteed. In Spain and Poland and certain other countries, banks are accustomed to such business and are prepared to make these guarantees.

German industry has long been supported vigorously by German banking institutions employing methods that could scarcely be used in the United States, so that even if German manufacturers are in a position to sell machinery on credit, it does not necessarily follow that American manufacturers would be in a position to handle their business on a like basis. Certain American industries that have felt the need for credit in connection with their export business have organized special institutions to finance these credits. Similar financial institutions have been organized in Europe.

It is also possible for an American machinery manufacturer to arrange for credit in connection with his export transactions by having these credits insured through companies equipped to underwrite such transactions. Such insurance protects only against bankruptcy, and present facilities cover transactions involving six months or less. Credits of this kind might be a great convenience to a machinery dealer abroad who would thereby by enabled to collect from his customer before finding it necessary to meet all payments in connection with the transaction. Manufacturers might find it profitable to study facilities of this character now in existence, and where it is found that a six months' credit is adequate, would possibly be able to promote their foreign business by employing such methods.

* * *

RUSSIAN TRADE PROSPECTS

Upon returning from Russia recently, Clifford N. Carver, American director of the German-Russian Transport Co., stated that Germany is conducting a fairly brisk business with Russia, importing a large quantity of furs and hides in exchange for machinery and other products. Leningrad (formerly Petrograd, and previous to the war St. Petersburg), which ten years ago had a population of 2,000,000 people now has a population of only 750,000. On the contrary, Moscow is very active, and the population there has increased from 1,000,000 to 2,000,000 in the last ten years. Moscow has become not only the seat of the Russian Government, but also the center of the commercial life of the nation. According to Mr. Carver, conditions in Moscow have greatly improved; there is an abundance of food, and practically anything can now be bought in the stores. Government management of the industries has not always proved successful, and the government is gradually abandoning the work and leasing the factories to their former owners, who are operating them profitably and efficiently. He also stated that his firm would export five shiploads of American agricultural machinery to Russia in the near future.

There has been quite an increase in the trade with Russia, and both machine tools and small tools have been exported to a considerable value. Reports from Germany also indicate that Russia has bought a great many machine tools there.

Trips and Control Dogs for Machine Tools

By FRED HORNER

IN REVIEWING the forms of control dogs used on machine tools, we encounter a great variety of types made not only according to the ideas of different designers, but for specific functions, which vary on different machines. The simple trip is a primary form consisting of a collar or block, while the more elaborate ones combine at least three functions—those of tripping, reversing, and starting a feed. A less complicated arrangement comprises a trip with a dead stop.

The requirements of sensitiveness vary considerably, for in some kinds of movements a comparatively simple trip suffices, while in others it is necessary to work to very fine limits. This calls for carefully constructed dogs that can be accurately adjusted, while the actual reversing mechanism must be well built for precise operation. Furthermore, it is frequently essential to provide for running past the dog positions for testing or other purposes.

Early Types of Control Dogs

The earliest type of control dog was placed upon a slidable rod, the dog being a simple collar held in place by a set-screw. The length of the movement imparted to the dog depended on the part it controlled, which was usually a belt-shipper that shut off the power. Clutch mechanisms were not at first made well enough for precise disconnection, nor was there any need to employ these in preference to the shifting belt. The rod and collar dog is still used in many machines, but its functions have extended to cover clutch actuation, the opening of dies, and certain kinds of twisting movements required in cases where a straight thrust is unsuitable. The application of a brake to check the motion of a slide or ram, when over-running would be undesirable, is another function controlled by the rod and collar dog.

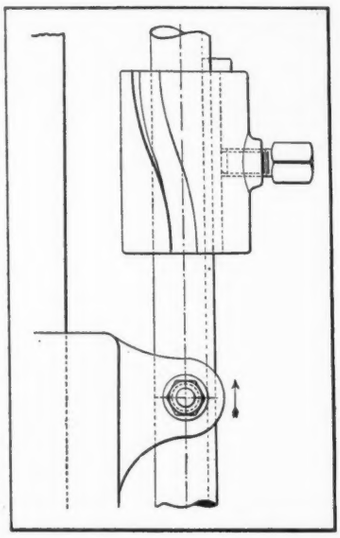


Fig. 1. Control Dog with Spiral Groove for obtaining Rotary Movement

In some of the earlier machine tools a weighted lever was utilized to produce a quick action when the dog began to operate, but the method was often a clumsy one when put into practice and the shock of the falling weight was frequently objectionable. With spring loading, as shown in Fig. 3, these objections are overcome. The dog compresses the spring until a certain degree of pressure is reached, when the spring releases and gives a rapid throw to the lever that operates the reverse apparatus. Broaching machines are commonly fitted with a dog of this kind, the reverse sometimes being accomplished by open and crossed belts, a clutch or a brake acting to check the travel of the head instantly.

Dogs Designed to Impart Twisting Movement

On the collar type of dogs on rods, a twisting movement must sometimes be imparted to the rod in addition to the endwise thrust. This movement may be required for feeding a tool-slide when the feed cannot be conveniently obtained in any other way. One type of slide-planer employs this device, as shown in Fig. 2. The dogs have rollers to contact against curved strikers on the traveling head. The belt shifting is thus accomplished by the endwise travel of the rod operating a slide that works the pivoted shippers, while miter gears effect the feed at each reversal.

In some cases it will be found that only a twisting action is utilized for the purpose of belt shifting. This method is employed for some of the big vertical and horizontal planers, the arrangement being such that the control shaft reaching across behind the traveling saddle is given a partial turn in its bearings when a roller dog is struck by one of the horns on the saddle. This turning movement is transmitted through miter gears to a rocking lever that actuates the belt shipper bar.

Some designers prefer to machine the twisted shape or cam upon the dogs instead of putting cam plates on the traveling element. Such dogs are cut with a twist similar to the horn shown in Fig. 2, or they may be grooved like the one shown in Fig. 1. Two of these dogs are splined to the trip-rod and held in place by set-screws. Roller-pins on the moving slide engage the twisted grooves and partly turn the rod to produce the clutch reversal. This arrangement is applied to a portable slotting machine.

Straight-thrust duplicate rods are occasionally provided for certain machines, one rod with its pair of control dogs dealing with the reverse, and the other rod giving the feed at each reverse by means of a ratchet mechanism. One form of machine having this arrangement is a portable valve-face planer, the slide of which is driven by a screw through miter gears, a clutch and a belt-pulley.

Rotary Trip-rods

A development that is of comparatively recent date is the rotary trip-rod, a device that enables a set of control dogs to be employed in a small space and with practically no trouble from dirt and chips getting between the contact surfaces. The rod is flatted or grooved according to the required number of trips desired, and the rotation of the rod is accomplished automatically by the indexing mechanism of a turret. Each dog trips and then acts as a dead stop. The dog may be made solid, as shown at *A*, Fig. 4, or adjustable, as shown at *B*. Hand rotation alone is depended on in certain cases where it would be impracticable for a connection to be easily made with the rotating element. A knob on the end of the dog-rod enables the four settings to be made.

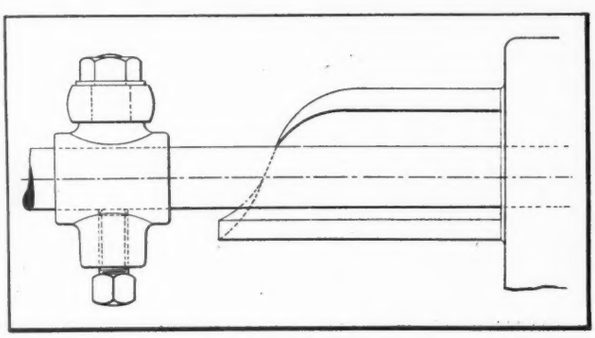


Fig. 2. Horn Type of Dog for imparting Rotary Motion

When a turret-slide and a cross-slide carriage are each provided with these rotating stop-bars, that for the turret is sometimes located up in front of its slide, and that for the cross-slide below the carriage in front of the bed. But often both bars are placed in line low down in front of the bed. In some turret lathes, a device is ar-

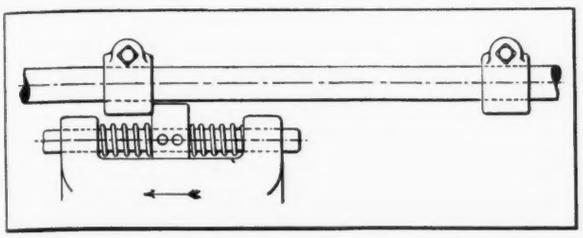


Fig. 3. Control Dog which acts against the Pressure of a Spring Block

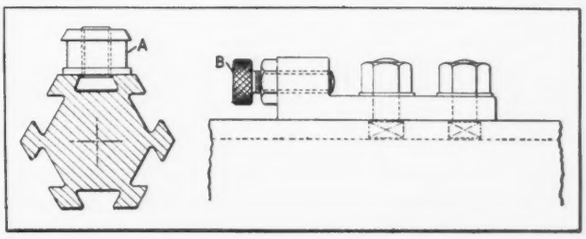


Fig. 4. (A) Plain Control Dog for rotating Rod; (B) Adjustable Dog

ranged for longitudinally adjusting the two stop-bars in unison to accommodate variations in the thicknesses of the work being machined. When the machining allowances are small, or the lengths of the rough pieces vary, this adjustment is very convenient.

Stop for Obtaining Exact Lengths

The difficulty of obtaining uniform pressures on the dogs when they are used as dead stops after the tripping of the feed, is surmounted by the use of the "accurate indicator." This is a fair-sized disk mounted on the pilot-wheel shaft of the turret carriage. The disk carries adjustable dogs, such as shown in Fig. 8, having index lines on them, which are lined up with a zero line on a fixed sector. By careful hand feeding at the last moment, these lines are brought to coincide, and exact lengths are thus obtained, regardless of changes in the pressure on the tools as they become slightly dulled.

A method of arranging control dogs is in the form of screws set in a revolving barrel which (unlike the slotted stop-bars just mentioned) travels with the element concerned, either a turret, or a cross-slide carriage. The arrangement is highly compact, and easily fitted to trip a worm or clutch drive, and then operate dead against some convenient abutment. The latter can be hinged in such a fashion that two dead stop positions are possible from one dog setting. If placed at the rear of a turret, the barrel containing the stop-dogs is rotated automatically in unison with the turret through the medium of bevel gearing.

For the longitudinal feed of a cross-slide carriage, such a barrel is rotated by hand to bring it into the proper position after each indexing movement of the square turret so that the appropriate dog-screw will be in line with the fixed rod which effects the tripping. One way of arranging the parts is shown in Fig. 14, the only portion of the carriage apron shown being the bearing *A*. The dog barrel *B* turns in this bearing and is locked in any of the four positions by a spring ball catch (not shown). The result of the contact of a dog-rod is to thrust the barrel backward, throwing the lever *C* over and working the collared rod that trips the feed. Then a slight further movement of the apron by hand brings the shoulder of bearing *A* against the shoulder of *B*, which acts as a dead stop.

Turret Lathe Trip

An exceptional kind of trip mechanism is used on one make of turret lathe for the longitudinal feed control. Six regular and three supplementary dogs or rods are located on a radius in a bracket secured on the front of the bed. The ends of these dogs come into contact with the stop-lever and knock-off block, according to how the lever is swung to bring its end into line with a particular rod. This oscillation is governed by a cam cut on the lower periphery of the turntable, the movement being transmitted by a roll, rack, pinion, and shaft.

In all those types of machines in which a table or saddle has to be tripped only at one spot, the usual practice is to have a dog fixed on the front, edge, or under lip of the table. Only in a few instances does a rod serve as the trip, this idea being chosen occasionally, as seen in the example illustrated in Fig. 5, which shows a gear-hobber saddle. The rod is clamped in a lug on the under lip of the table, and slides in another lug on the bed. The micrometer gives a fine length setting for deciding the tripping point which, in turn, regulates the depth of tooth.

Of the dog mentioned in the preceding paragraph there are many varieties, operating in different ways upon the trips or levers, and with solid or adjustable construction. Some of them include a throw-off feature which allows the table to be run past the tripping position for testing, inserting the work, or other purposes without disturbing the setting of the dog. In some cases, a dead stop action is performed by the trip-dog, while in others, a separate dog performs this function.

Simple Arrangements of Tripping Mechanism

It is not so common to find direct contact of a dog with the actual trip-lever, as it is to find a more roundabout arrangement of plungers, levers, etc., often concealed in a table or knee or head leading to the point of disengagement, by drop-worm, clutch, or other mechanism. But sometimes in simple feeds the termination of a worm-box may be brought out below a table in the manner shown in Fig. 7, within convenient reach of the catch-lever, so that the top end of the latter may be in line with the dog in the slot beneath the rim. The edge of this dog has a double bevel and will trip in either direction of feed. Another relatively simple lay-out occurs when a clutch lies inside, say, a knee, close to the sliding element. The clutch-actuating lever then only needs to be put on a short shaft, at the other end of which is an outside lever suitable for operation by the dog shown in Fig. 6.

Further complication occurs when the tripping must be accomplished at a distant point, an illustration of which appears in Fig. 9, which shows a front view of a vertical-spindle milling machine table. The drop-worm, being lo-

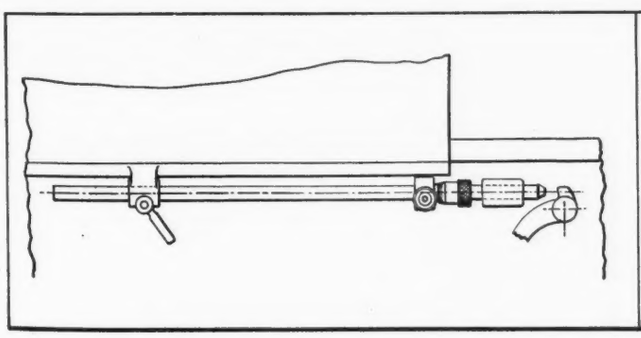


Fig. 5. Rod Type of Control Dog, with Micrometer Adjustment

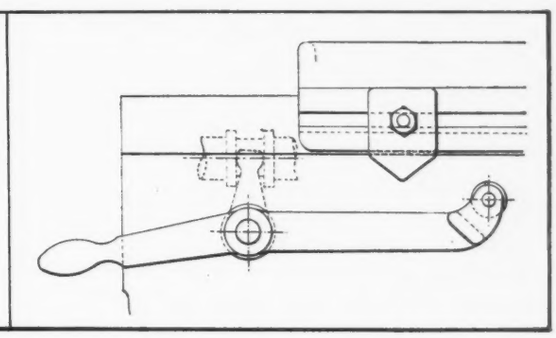


Fig. 6. Lever with Tripping Action inside Machine Knee

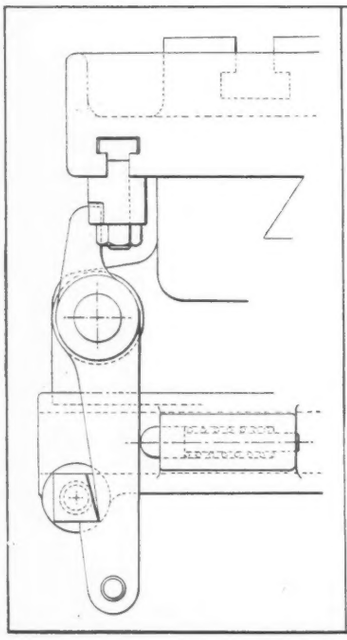


Fig. 7. Beveled-edge Dog which acts directly against Drop-worm Catch

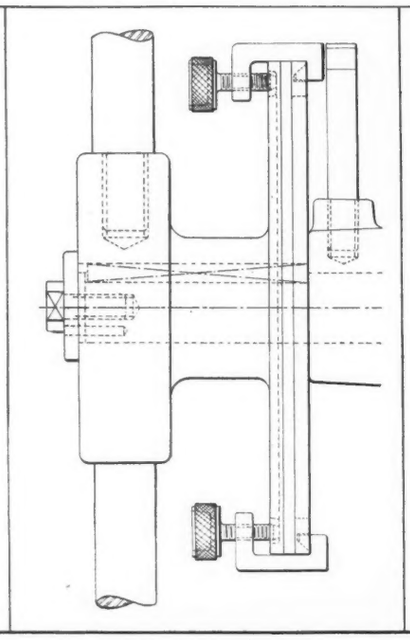


Fig. 8. Adjustable Dogs mounted on Disk provided with Index Lines

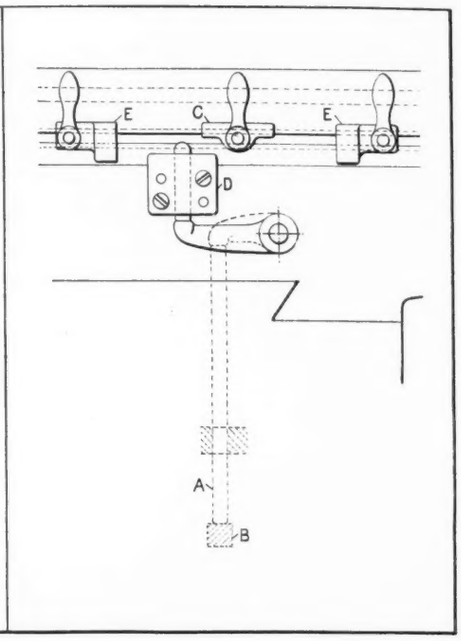


Fig. 9. Plunger and Lever Arrangement for actuating Tripping Mechanism

cated back within the column, is worked by a long bar passing through the knee. The trip-rod *A* is seen resting on this bar, sectioned at *B*. As dog *C* is carried along by the table it pushes down the plunger in block *D*, and through the bellcrank levers depresses *A*. The dogs *E* act as dead stops, when suitably set to abut against the sides of block *D*.

The objection to a multiplicity of levers and joints and contact surfaces is obvious. If a sensitive trip is desired, the rack-plunger operating a pinion is much favored to get instant response without torsion or lost motion. A trip of this kind is shown in Fig. 10, the pinion being cut on the shaft which works the clutch fork inside the saddle. In some cases the pinions are actuated by one rack-plunger, but in the design shown in Fig. 10 the double-plunger principle is adopted. A spring-lock retains the hand-control lever in position by the countersinks in the stop-plate. The dogs, it will be noticed, reach to the under lip of the table, there being insufficient room to put bolting facilities beneath, as is done with planer type millers and other large machines.

Dogs on planers are either bolted to the edge or the under lip of the table, and are subjected to hard use. The practice of putting a hard steel lip or facing on the striking part of each dog increases its durability, while a roller on the tumbler also reduces friction and wear. The use of these dogs at one time was only for shifting belts, but other methods of planer driving have developed, including magnetic clutches and reversing motors.

Variable-speed Control

The employment of an accelerating switch is further responsible for modifications in the positioning of dogs, because this form of switch is controlled by tappets suitably arranged on the table edge so as to speed up the table between two cuts that are some distance apart. The apparatus is also utilized to increase the cutting speed after the tool has entered the work slowly, with the idea of preventing shock to the delicate edges. Furthermore, should there be hard patches in the work, the speed can be slowed down at these points and the remainder of the surface be cut at the usual rates.

In some cases the rear dog is formed with a pivoted latch, as shown in Fig. 11, when it is desired to let the table run forward without disturbing the setting of this dog. But a more common device and a safer one is that of hinging a "trip" to the tumbler lever, this trip being rocked as required by a small handle. Convenient control of planers as they reach the larger sizes, from about 36 inches upward, is insured by duplicating the dogs and shifter mechanism on each side of the table, so that the operator may set the dogs and start the cut from either side.

Control Dogs on Automatic Millers

Production on milling machines has been greatly speeded up by new multiple-dog arrangements. Various effects are procurable in this manner. For example, on one type of automatic milling machines, fast or slow feeds can be pro-

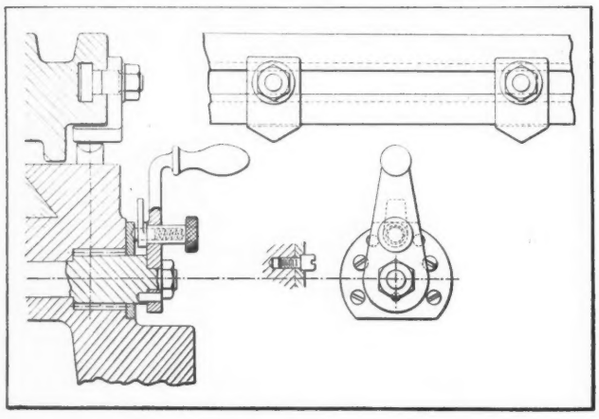


Fig. 10. Dog and Rack-plunger Control

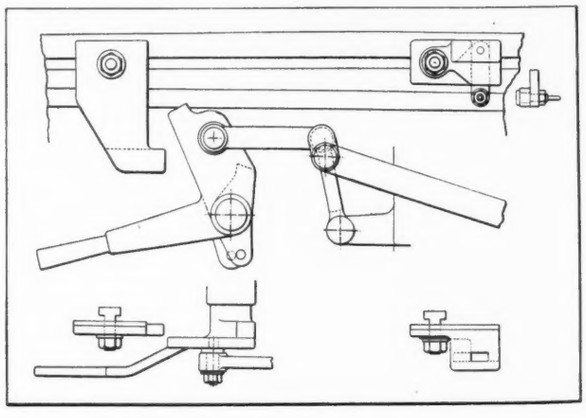


Fig. 11. Type of Dog employed on Planer

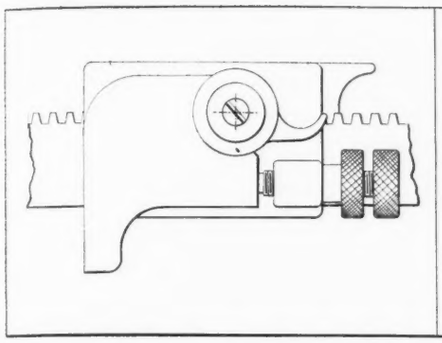


Fig. 12. Rack Set Dog with Screw Adjustment

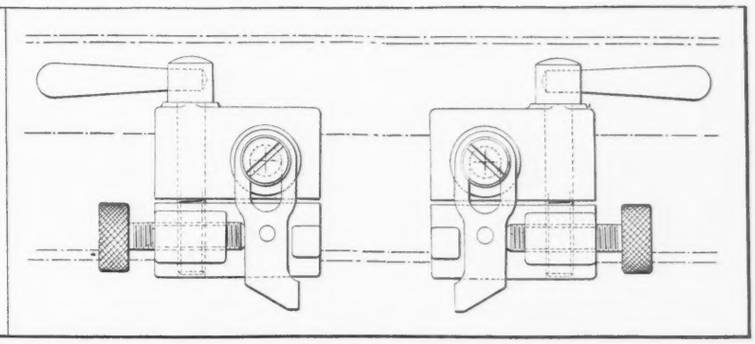


Fig. 13. Adjustable Control Dogs employed on an Internal Grinder

duced in either direction, with automatic reversal and automatic stopping. Dogs are also included for reversing the spindle. In this case, two cutters are mounted on the arbor with teeth facing in opposite directions.

On another milling machine fitted with automatic control there are two T-slots in the table edge, for the reception of different arrangements of dogs by means of which about twenty different cycles may be obtained. Without the extra dogs, the feed operates in the regular way in either direction, and is tripped automatically. With added dogs, the feeds in either direction, the stops, reversals, and various accelerations at required spots are effected. Every fraction of time is thus saved on the "wind" spaces, in reversals, and in restarting, while no mistakes can be made, as often happens when attempts are made to save time in the same manner by hand manipulation of the control levers.

Many years ago an English machine tool builder introduced a special dog arrangement on some of its manufacturing millers in which two dogs, in combination with a special construction of tumblers, detents, springs, and clutch, enable the work to be moved up rapidly by hand to the cutter, and at a predetermined distance from it the feed is automatically engaged. Waste of time is consequently avoided, and there is no risk of damage to the cutter. One dog also trips the feed when the limit of travel desired has been reached, and the table is run back by hand ready for the next cycle.

Dogs fitted with means of adjustment for obtaining exact trippings, and sometimes also dead stop positions, are employed on certain classes of machines, grinders being in the lead. The adjustment depends either on a pivotal action, or upon direct screw setting. Fig. 13 shows the dogs of an internal grinding machine with pivotal regulation. This style also appears in a modified form on cylindrical grinders, but instead of having the dog clamped on the dovetail ledge at the table edge, a rack is used and the dog is held by a thumb-latch, as shown in Fig. 12. With direct screw-setting, the adjustment may be by means of a plain screw and lock-nut, or a micrometer arranged as shown in Fig. 16.

Control Dogs for Rotary Elements

Dogs that move in a circular path are used when the element to be tripped has a rotary motion, such as a circular table used for milling or other processes. A T-groove around the rim or beneath it holds the dogs that operate the tripping mechanism controlling the clutch or drop-worm. A trip-dog is likewise necessary on the special circular and profile milling machines or the cam millers to throw out the feed either at the finish of the full circle or the path around the piece, or at any earlier point.

An automatic withdrawing motion is sometimes incorporated to make the work recede from the cutter at the termination of the cut, so as to prevent a depression at that spot. This action is operated from the feed trip-dog just before the trip actually occurs. A further device, also worked from the same dog when required, is that producing two rotations of the work, one roughing, the other finishing; the trip-lever is so shaped that the same dog moves it in two ways to effect the result mentioned.

The other need for a dog having a circular travel instead of a linear-moving dog, is to control the feed or the speed-changing of machines. It may often happen that the linear-moving dog is quite feasible, but it is not to be preferred to the circular class. In automatic screw machines there are numerous examples of dogs located on disks or drums, either in permanent positions or easily adjustable by bolts or cap-screws. With this arrangement, feeds and speeds can be changed, reverses produced, and other effects obtained. Much attention is now paid to dog arrangements which run tool-slides up at a fast rate quite close to the cut, when another dog throws in the cutting feed. Additional control of the feeds is also evolved by fitting a pin into a dog-block which has several holes at various lateral positions, thus giving one dog control of a wide range of speeds.

Drilling Machine and Boring Machine Trips

The disk with trip-dogs arranged on it is rapidly gaining favor as a means of controlling the operation of drilling machines and turning and boring mills, as a substitute for

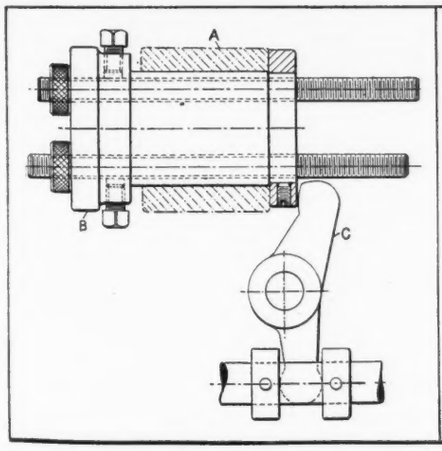


Fig. 14. Threaded Dogs mounted on Revolving Barrel

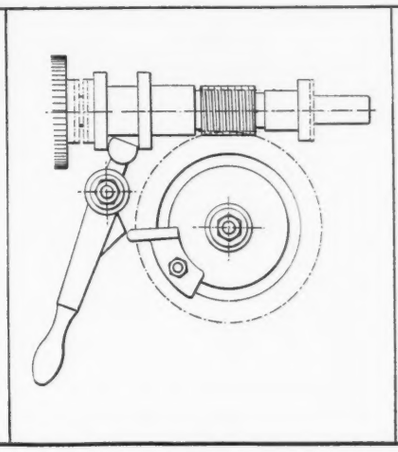


Fig. 15. Trip-dog mounted on Worm-driven Dial

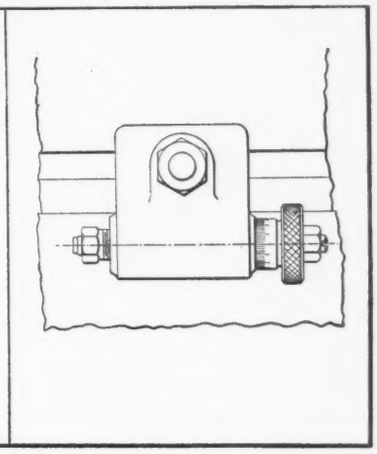


Fig. 16. Dog provided with Micrometer Adjustment

direct trip-dogs secured to the moving spindle, saddle, or tool-ram. The disk on which the dogs are clamped may be a worm or spur gear acting directly upon a rack-pinion or a screw, or it may be a dial driven through spur gearing from the rotating element, or by worm-gearing as shown in Fig. 15. A definite portion of a revolution gives a certain amount of feed.

The dogs are set by trial in some cases, but in the more advanced practice they are set according to graduations upon an adjustable dial, a method which is rapid and very accurate. A releasing latch is often provided to enable the feed to be continued further (by power or hand) in special cases, leaving the automatic trip undisturbed for subsequent pieces. When dogs happen to be set on the periphery, instead of on the face of a disk, a good method of adjustment is provided by a screw, acting in a worm thread on the edge. For rapid settings before the final adjustments, the screws are arranged pivotally, to be lifted out of engagement, and then allowed to fall into mesh under the action of a spring, for delicate regulation.

A final note should be made regarding safety dogs, a type separate from the normal control dogs. They are fitted on various kinds of sliding tables, heads, knees, or saddles, and stand at places determining the safe limit of travel. When this is reached, the permanently set safety dogs trip the feed. If such dogs are not applied, there is generally some other safety measure provided, such as a slipping clutch or a soft steel shearing pin in the drive.

* * *

GRINDING LOCOMOTIVE RODS

By C. G. WILLIAMS

The writer read with interest the article entitled "Equipment for Grinding Locomotive Rods," on page 714 of May MACHINERY, in which a device similar to one used for many years in the shops of the Pennsylvania Railroad Co. was described. Equipment for handling the same kind of work, but which the writer believes to be more efficient was made up from an old surface grinder in a railroad shop at Little Rock, Ark. The surface grinder employed was very old, having once been used to grind the guides employed on the four-bar guide cross-head engines used thirty years ago.

The old surface grinder was repaired, and a bed made that would accommodate a table 20 feet long. This table was so arranged that stops could be employed to give a table travel of from 2 to 19 feet, as the work required. By using different styles of grinding wheels, every part of a side-rod or main-rod could be ground to a smooth surface. Grinding wheels were used in this manner to remove the hammer marks and worn spots, while a buffing wheel was employed to give the rods a high polish. An Ingersoll-Rand air lift was used with this equipment for lifting and turning the work.

* * *

PATENT OFFICE CONDITIONS IMPROVED

Despite a larger volume of business, the Patent Commissioner's report to the Department of Commerce, to which the Patent Office has recently been transferred, shows that the conditions of the work in the Patent Office have greatly improved. Although there were 1900 more new applications and 30,000 more amendments received during the last fiscal year than the previous year, the close of the year found the Patent Office with 16,000 fewer cases awaiting official action than a year ago. On June 30 there were 43,000 cases pending, against 59,000 a year ago, and 72,500 on June 30, 1923. According to the Patent Commissioner's report, during the year just closed his office has decreased the average time that an application must await official action by two months in new work, and one month in old work, so that the average time that a new application must await to receive official action has been reduced from five months to three, and the average time an amended application must await official action has been reduced from about three and one-half months to two and one-half months.

HARDENING HIGH-SPEED STEEL IN BARIUM CHLORIDE BATH

By A. L. VALENTINE

About fifteen years ago the writer made some experiments on the hardening of high-speed steel in barium chloride baths, electrically heated, the results of which were described in April, 1911, MACHINERY. The experiments indicated that, on the whole, the hardening of high-speed steel in barium chloride electrically heated baths was not very satisfactory. The results of the hardening were good when the salt bath was new, but it appeared that the chemical composition of the salt bath in the electric furnace gradually changed, producing a soft surface on the steel which was quite noticeable when the salt bath had been in use for about a week. This softness of the surface was noticeable directly after the hardening, and not merely after the temper had been drawn.

A certain sediment collected in the electric salt bath, and the color of the barium chloride became darker. The same barium chloride melted in an ordinary graphite crucible retained its lighter color, and even after two full weeks' use, the hardening results were satisfactory. The amount of barium chloride used in the electric furnace was much greater than that required for doing the same amount of work in a graphite crucible.

Since that time the writer, while engaged in small tool manufacture in France, again had occasion to make use of electric salt baths for hardening high-speed steel, but this time successful results were obtained. Experiments made in Sweden several years ago have also been called to his attention, which also indicated that it is possible to obtain perfectly satisfactory results by hardening high-speed steel in electric barium chloride baths.

The reason for the difference between the results obtained in the experiments recorded in MACHINERY fifteen years ago and those undertaken at a later date are due to the differences in the character of the crucible containing the barium chloride bath. If silica brick or clay is used for the crucible, it will be found that there is no chemical action and that high-speed steel can be hardened without any soft spots on the surface. The risk of breakages in hardening also appears to be diminished, when there are no soft spots on the surface. The objectionable results, therefore, in the early experiments are almost certain to have been due to the character of the lining of the crucible and the chemical action of the electrically heated salt bath on this lining.

When the proper kind of crucible is used, it appears that properly conducted hardening of high-speed steel in electrically heated salt baths cannot be surpassed by any other hardening method, as regards either the accuracy with which the temperature can be obtained and maintained, the hardness of the surface, or the freedom from hardening cracks.

* * *

DO WE SUFFER FROM TOO MUCH EDUCATION?

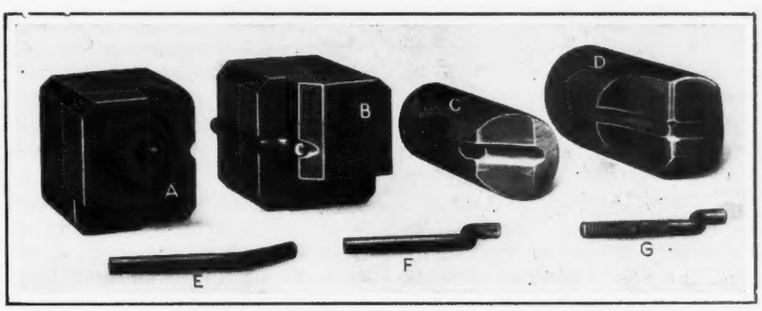
In discussing apprenticeship training, at a recent meeting of the American Society of Mechanical Engineers, H. A. Frommelt, of the Falk Corporation, Milwaukee, Wis., said that the objections ordinarily voiced regarding apprenticeship had absolutely no foundation. One objection, he said, was that the boys were going into higher education. However, figures published by the United States Bureau of Education showed that out of 100 children, only 67 were graduated from the eighth grade, 34 entered high school, 16 were graduated from high school, 7 entered college, and only 2 were graduated from college. Another objection was that the boys were going into "white collar" jobs. This tendency, he showed, was because of the manner in which they were received and treated when they attempted to learn a trade by entering an industry; in other words, the boys were not running into the "white collar" jobs, but were running away from the shop conditions.

FORMING HOOK-BOLTS ON AN AUTOMATIC HEADING MACHINE

By ARTHUR L. GREENE

Bolt and nut manufacturing plants receive many orders for special types of bolts. The filling of such orders often necessitates the making of special equipment, which, of course, means additional expense to the customer. One of the varieties of special bolts most commonly ordered is the hook-bolt. The manufacture of bolts of this kind generally necessitates the making of a special set of dies, the cutting of the wire to length, and the employment of a hand-fed press for the forming operations. This ordinarily requires individual handling operations or, in other words, it means that automatic and semi-automatic heading machines cannot be employed in the usual manner. The Buffalo Bolt Co., North Tonawanda, N. Y., however, succeeded in equipping an automatic cold-heading machine in such a manner that it was used satisfactorily in filling an order for 10,000 special hook-bolts like the one shown at *F* in the illustration. The dies designed for this job, and the method of employing them as described in the following, resulted in completing the order in about one-third the time that would have been required by the methods formerly used for orders of this kind.

The two open gripping dies are shown at *A* and *B*. It will be noted that these dies are practically square in cross-section and that a section of the metal has been removed at the lower front sides. On the face of die *A* and exactly in its center is a groove of the same radius as the bolt. It will be noted that a section of metal has been cut from the bearing surface side as well as from the bottom side of the gripping die shown at *B*. One of the bent bolts is shown in place in the groove cut in the front face of this die. This groove follows the outline of the cut-out section, and has the same radius as the bolt. The corners of the groove are relieved slightly at the turns, the outer corners of the two gripping dies being relieved to permit the entrance of a wedge-shaped tool for separating the dies after forming.



Dies and Forming Tools used in producing Hook-bolts

Forming Dies

At *C* is shown the first of the two forming tools. This tool is circular in shape, and its working end is relieved at an angle. Extending lengthwise in the face of this relieved section, and directly in the center, is a groove of the same size as that cut in the gripping dies. The flattened portion of this die just back of the working end provides a bearing surface for the set-screw that holds the tool in the machine.

At *D* is shown the finish-forming tool, which is also circular in shape but larger in diameter than the first forming tool. The relieved end of this tool is tapered, as shown, and grooved along the tapered side and across the end. The radius of this groove corresponds to the radius of the bolt. The groove is relieved to some extent at the point where the right-angle bend is made.

Operation of Dies

The location of the dies and forming tools in the automatic heading machine is as follows: The two open gripping dies *A* and *B* are placed in the machine with the inner or grooved surfaces facing each other. These dies are left open in order to permit the stock to be inserted between them. Placed next in position, and above the dies is the first forming tool *C*. Back of the forming tool *C* is the second forming tool *D*.

The wire is fed automatically from an upright reel between a pair of dies, until it reaches a stop. The dies *A* and *B* next move automatically to the side on a slide, and to a position directly under the forming tools. During this movement the wire is cut off to the required length. The die then closes on the piece of wire, and holds it in position while the hook end is formed. Next the first forming tool *C* moves downward, bending the end of the wire to the right at an angle corresponding to that of the relieved section of the tool, which in this case is 60 degrees. At this stage the wire has the shape indicated at *E*.

The tool *C* next returns to its original position, and the second forming tool *D* comes into operation. This forming tool, in turn, moves downward, pressing the bent end of the wire into the forming groove in the second gripping die *B*. The upper half of the wire fits into the end and side groove incorporated in the second forming tool *D*. At the end of the downward stroke of tool *D*, the forming operation is completed, and the hook-bolt drops out of the dies into a container placed on the floor. The bolt now has the form shown at *F*, and is ready for the threading operation, which is performed on a semi-automatic threading machine. The latter operation completes the finished bolt shown at *G*. Some idea of the speed with which the forming operations take place may be had from the fact that the complete order of 10,000 bolts was run through in about three hours.

* * *

A booklet of considerable interest to all employers, entitled "Lunch-rooms for Employes," has been published by the Metropolitan Life Insurance Co., New York. This booklet maintains that a hot lunch in the middle of the day is conducive to better work in the afternoon. Such lunches are now being served by more than four thousand companies in the United States and Canada, according to the report. The Metropolitan Life Insurance Co., itself, in its office building in New York, maintains one of the largest industrial cafeterias in the country, where lunches are served daily, on working days, to about 9000 employes. In the report mentioned, copies of which may be had free of charge from the Policy-holders Service Bureau of the Metropolitan Life Insurance Co., New York City, such questions as the kind of room required, necessary equipment, cost analysis, methods of controlling materials and expenses, are covered. In the preparation of the report, the practice of such well-known concerns as the General Electric Co., the International Harvester Co., the Eastman-Kodak Co., and the National Cash Register Co., as well as numerous smaller organizations, has been covered.

* * *

The cost of waste and wiping cloth in manufacturing plants operating machinery of all kinds is not a small item. In many factories it has been the practice to destroy this material after it has become soiled. Within recent years, however, laundry equipment has been developed for cleaning waste and wiping cloth for subsequent use, the cost of reclamation being about 20 per cent of the cost of new material. It is stated that this process of reclamation can be repeated from ten to thirty times, according to the quality of the material. Cleaning equipment of this kind is now installed in a number of well-known metal-working plants, and is giving very satisfactory results. The apparatus consists mainly of a standard washing machine used in connection with drying machines.

Prospects in the Foreign Machinery Trade

DURING the past year there has been a noticeable improvement in the foreign trade in machine tools, small tools, and industrial machinery in general. Not all classes of machinery have been in demand; production tools and special machinery have been mostly in demand in European markets, while the medium grades of standard machine tools have been most generally bought in the non-European fields. With the view to place on record definite, first-hand information from abroad, relating to the foreign trade in machine tools, MACHINERY has obtained from leading dealers, in Europe, specific information bearing upon important questions concerning the export trade. A summary is published in the present article.

While the picture presented does not indicate that the prospects for business in machine tools are such as characterized pre-war days, and while the industrial and political situation in most of the European countries is, as yet, unsatisfactory and uncertain, it nevertheless is a fact that machine tool imports into most of the European countries have increased steadily for the past two or three years.

Industrial Conditions in Great Britain

According to Burton, Griffiths & Co., Ltd., machinery dealers of London, of the 11,514,000 industrial workers of Great Britain, 1,250,000 are out of employment, chiefly in the mining, shipbuilding and metal-working industries. This depression has now lasted over four years. Nevertheless, machine tool imports from the United States have increased during the past three years. In 1922, the machine tools imported from the United States into Great Britain were valued at £239,300. In 1923, this value rose to £278,600, and in 1924, to £341,700. These imports do not represent altogether new machinery, as a large proportion was second-hand machines. During the first four months of 1925, the imports from the United States amounted to £153,000, showing an increase over the same period in 1924.

It is likely that the increase in imports of American machine tools will continue for the remainder of the year, but American manufacturers are warned against increasing their prices in the British market. In the last few months, in cases where this has been done, it has encouraged both domestic and continental manufacturers to increased effort. In one case, an order had been definitely placed for a number of high-class American machine tools, but when the customer was advised of an increase in price, the order was cancelled and a British manufacturer was given the business.

During 1924, machine tools were imported from Germany to a value of £140,000.

The industries that are best occupied are those engaged in automobile building and in the construction of electrical machinery. The American machine tools that find a most ready sale in Great Britain are special grinding machines, gear-cutting machines, multiple-spindle drilling machines, automatic lathes, and special crankshaft machinery.

Prospects for American Machine Tools in France

The further depreciation of the French currency gave an impetus to export business, and 1924 was a busy year in almost every branch of industry. During the present year there has been a slight falling off in some branches, approximately 25 per cent in the forge shop business and perhaps 30 per cent in the smaller plants engaged in automobile building. The shops building railroad equipment have very little business; on the other hand, the principal automobile manufacturers, plants engaged in general machine building and the building of agricultural and electrical machinery, are fully occupied. The activity for the remainder of the year is likely to suffer because of lack of confidence, and the present activity may not be maintained. The best prospects are for agricultural machinery, automobiles, electric power plant equipment, and radio and telephone equipment. The chief demand is for special machinery for production purposes, especially milling machines, grinding machines, multiple drilling and tapping machines, and automatic machines.

Most of the importers of machinery are doubtful about the outcome of the commercial agreement between France and Germany that will remove the 26 per cent extra duty on German goods and will permit them to enter at the minimum tariff. No doubt this agreement will handicap the sales of some American machines. The prices of German machines are generally high and with the tariff as in the past, they have just about been able to compete with American machines on price. A reduction in the tariff doubtless means lower prices on German machines and greater activity in pushing them in the French market.

A Summary of the French Industrial Situation

One dealer summarizes his opinions as follows: "We are of the opinion that only specialized and high-production machine tools of a type that are not manufactured in France, can be imported from the United States. Ordinary machine tools cannot compete with the domestic machines which are produced at from one-half to one-third the American price."

Another dealer points out that the French market for machine tools is now quite dull as compared with the activity towards the end of last year, which was quite satisfactory. The political situation and the recently imposed taxes are given as the chief reasons for the present depression. Manufacturers are hesitating to extend present plant facilities. There is, however, no unemployment in France, as compared with England. Furthermore, there are likely to be numerous Government orders for the industry to be filled during the remainder of the year.

The Belgian Industrial Activity Has Fallen Off

The year 1924 was a good year in Belgian industry, but according to Henri Benedictus & Co., machinery dealers of Brussels, the present activity in the metal manufacturing industries is perhaps only 50 per cent of what it was last year, when the industries were fully occupied. The chief reasons for this depressions are the uncertainty of international affairs, and hesitancy on the part of capital due to present internal politics. Furthermore, the foreign countries where Belgium formerly had her most important customers, have built a protective tariff wall against the Belgian industry, forcing Belgium to look for other markets.

"The outlook for the remainder of 1925," says our correspondent, "is not bright, and we do not believe that the situation will be much improved. There are, however, a few exceptions; the manufacture of firearms is active, which is quite natural considering the disturbances in many quarters; one of our motor car manufacturers is also busy, as are also some woodworking machinery and machine tool builders. Due to the high tariff, the domestic manufacturers of machine tools have a good many orders on hand.

"Special automatic machinery, gear-cutting machines and grinders are the only American machine tools likely to be imported. The regular lines of lathes, planers, shapers and drilling machines will not find much of a sale in the near future."

Le Vulcain Belge, machinery dealers of Brussels, point out that internal difficulties in the industries, such as a threat-

ened general strike, and numerous strikes in individual plants, have caused a considerable recession in business and that many plants have materially reduced their working forces.

Among the machines in demand are plate-edge planing machines, circular shearing machines, automatic lathes, and multiple-spindle automatics, but the high exchange rate has practically prevented any orders from being placed. "In a general way," continues our correspondent, "we think that the importation of American machine tools will never again reach the volume of past years, especially of the years immediately following the war, because many Belgian and French firms have engaged in the manufacture of machine tools and have already obtained quite remarkable results. We therefore believe that the only American machines that will be in demand in Belgium in the future, will be those of very special construction that are not built in France or Belgium and for which the prices of English and German types would be too high."

No Important Change in Holland

The present activity in the metal manufacturing industries in Holland remains about the same as in 1924. There is no prospect for a change in the near future. Business is not active in any line, and therefore American machine tools are not in demand, although there is some business in American twist drills and taps. Some dealers have big stocks of American-made machine tools that they are now selling at prices far below actual value.

The Situation in Germany is not Satisfactory

The German industry still hesitates. The political situation is not sufficiently encouraging to permit industrial plans taking definite shape and materializing. The automobile industry is the only one that, at the present time, is really busy. This industry is increasing its plant capacity and equipping its shops with the most modern machine tools obtainable. Hence, there has been a comparatively great demand for American machine tools, especially automatics, gear-cutting machines, grinding machines, crankshaft lathes and other special machines for automobile work. The German machine tool builders that produce machines of this type also have plenty of orders. Generally speaking, however, capital is scarce and no expansion in general business is in sight until both the domestic and international political situation is somewhat more settled than it now is.

The Business Situation in Austria, Czechoslovakia and Hungary

In Austria, the general business situation remains about the same as in 1924, while the industries of Czechoslovakia and Poland are probably 50 per cent better employed than they were last year. An improvement is, however, expected also in Austria. Here the electric power plant equipment industry is best occupied, both for domestic business and for exports to Italy. The automobile industry is also active, while the industries in Czechoslovakia and Poland appear to be chiefly occupied, directly or indirectly, on production of war materials. The American machine tools that are in demand are only those that are not built in Europe, such as automatic and semi-automatic machines and centerless grinding machines. Only a few plants that especially favor American machine tools are interested in the more standard lines of machines.

Baranyai Imre, a dealer of Budapest, points out that the Hungarian metal manufacturing industries have lost a great deal of their market through the lost territory of Hungary; hence, they have had to reorganize to meet the new conditions. During the present year the Hungarian currency has been stabilized, but the metal manufacturing industries employ only about 80 per cent of the workmen employed last year. However, conditions are improving, and for the remainder of the year greater activity is expected. The best business is in electrical and agricultural machinery fields. Since the war, most of the machine tools sold in Hungary have been of German origin, but of late a few first-class American machine tools have been bought—automatic screw machines, milling machines, grinding machines, and turret lathes. The demand, in the future, will be only for first-class machine tools that can compete in quality with German makes. Highly developed specialized automatic machines are not in demand as there is no real mass production in Hungary.

Industrial Conditions in Italy are Good

The industries of Italy have been quite active during the past year and there is more business than in 1924. The prospects for the near future are for a constant increase, but owing to the high rate of exchange and the large import duty, there is, at present, no great likelihood for substantial business in machine tools with the United States, except when high-production special machines are needed.

Conditions in the Swiss Industry are Improving

Compared with 1924, the present activity in the metal industry in Switzerland is slightly greater. The number of men employed by the Swiss Association of Machine Manufacturers which was 43,000 men in January 1924, increased to 47,000 men in April, 1925. The present activity is likely to continue for the remainder of the year, although there has recently been some complaint of a reduction in new business. The most active lines are textile machinery, electric locomotives, and bridge-building.

The types of American machine tools that have been sold recently are grinding machines—plain and cylindrical—centerless grinding machines, gear-cutting machinery, single- and multiple-spindle automatics, and small measuring tools. The number of these machines required by Switzerland is, however, very small.

In 1924, the value of German machine tools imported into Switzerland was 6,556,000 francs; American machine tools were bought to a value of 213,000 francs. The German prices are still from 30 to 50 per cent below the American quotations.

Agricultural Machinery Industry Most Active in Denmark

The employment in the machine shop field in Denmark is approximately equal to that in 1924. The shops are generally well employed and expect to be so for the remainder of the year. The greatest activity is in agricultural machinery; the Diesel motor industry is also active, as well as some of the plants engaged in building electrical machinery.

It is difficult to sell American machine tools in the Danish market because of their price. Even admitting their high quality, the price is much higher than that of European tools of modern manufacture. With an improvement in the Danish exchange rate this may be overcome. In Denmark the best chances for imports are for small tools, because it is generally admitted that American small tools are still superior to the best European, and American prices are satisfactory in the Danish market.

The Swedish Industries are Recuperating

Compared with 1924, the industrial activity was at least 25 per cent greater during the first six months of this year, most plants running at about 75 per cent capacities. The activity for the remainder of the year will doubtless keep to the same level. Oil engines, both Diesel and semi-Diesel, cream separators, ball bearings, telephone instruments, electrical and water turbine equipment, and shipyards building motor ships, are among the lines that are most active, and many of these have important orders for export. Competition, however, is very keen, and quotations frequently leave no profits—sometimes losses—and the American machine tools in demand, as in most of the other European countries, are principally special machines—automatics and single-purpose machines. It is generally considered that American prices are high and Germany is getting a fair share of the business, as numerous machines now coming from that country are of satisfactory design and workmanship.

Norwegian Industry is Quiet

In Norway the industrial activity is not very marked and there are no signs of an immediate improvement. There is very little demand for shop equipment. The improvement in the Norwegian exchange, while it should have a favorable influence on exports to Norway, has so unfavorable an influence upon the sales of Norwegian products abroad, that there is no confidence on the part of those who might be able to buy. The only shop accessories that have a chance of sales at the present time in Norway are small tools of high quality, and portable drilling, boring and polishing machines, electrically driven. Competition in small tools, by Germany and Sweden, is, however, very keen. The only Norwegian industry that may be said to be busy is the one engaged in manufacturing aluminum.

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NEW HAVEN MACHINE TOOL EXHIBITION

The demand for exhibition space at the New Haven Machine Tool Exhibition, to be held September 8-11 at the Mason Laboratory of the Sheffield Scientific School of Yale University, has been so great on the part of firms in the Middle West, as well as in the eastern part of the country, that it has been found necessary to open up additional space on two floors of the Mason Laboratory. In conjunction with the Exhibit, technical meetings have been arranged by the Machine Shop Practice Division of the American Society of Mechanical Engineers. These meetings will be held in the Dunham Laboratory of Electrical Engineering, directly across the street from the Mason Laboratory. The program for the technical sessions is as follows:

Wednesday afternoon, September 9, at 3:30 p. m.: The first paper at this session will be "Centerless Grinding," by W. J. Peets, factory methods engineer, Singer Mfg. Co., Elizabethport, N. J. This paper will be illustrated by lantern slides. F. O. Hoagland, of the Saco-Lowell Shops, Boston, Mass., will preside at this session.

Wednesday evening, September 9, at 8 p. m.: At the evening session, the first address will be delivered by O. B. Iles, president of the National Machine Tool Builders' Association and president of the International Machine Tool Co., Indianapolis, Ind., the subject being "The Future of the Machine Tool Industry." Following this address, W. H. Rastall, chief of the Industrial Machinery Division, Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington, D. C., will speak on "The Foreign Trade Outlook in the Machine Tool Field." This will be followed by a paper on "All Metal Airplanes," by William B. Stout, president of the Stout Metal Airplane Co., Detroit, Mich. The latter paper will be illustrated with moving pictures.

Thursday afternoon, September 10, 3:30 p. m.: Paul M. Mueller, engineer of the Pratt & Whitney Co., Hartford, Conn., will read a paper on "Cylindrical Precision Lapping," illustrated by lantern slides. This will be followed by a paper by Luther D. Burlingame, industrial superintendent of the Brown & Sharpe Mfg. Co., Providence, R. I. on "High-speed Cutting of Brass." Ralph E. Flanders, manager, Jones & Lamson Machine Co., Springfield, Vt., will preside.

Thursday evening, September 10, at 6:30 p. m. there will be a "round table dinner" arranged with four tables, for the discussion of a like number of topics. One table will be devoted to inspection methods and precision measurements, where the discussion will be led by Earle Buckingham of the Niles-Bement-Pond Co., New York City. Another table will be devoted to power press work. A third table will discuss production milling under the guidance of Walter Tangeman of the Cincinnati Milling Machine Co., Cincinnati, Ohio, and at the fourth table, shop training methods will be discussed.

Friday afternoon, September 11, at 3:30 p. m.: This session will be devoted to shop training methods. One of the papers to be read will be by H. A. Frommelt, apprentice superintendent of the Falk Corporation, Milwaukee, Wis., the subject being "The Development of a District Apprentice System." A second paper will be presented by John P. Kottcamp of the Johns-Manville, Inc., New York City, on "Serving the Industry by Two-year Courses for Shop Executives." Mr. Kottcamp was formerly connected with the Pratt Institute of Brooklyn, and was instrumental in developing such courses. A number of the papers above are abstracted in this number of MACHINERY.

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STEEL TREATERS AND AUTOMOTIVE PRODUCTION MEETINGS

The production meeting of the Society of Automotive Engineers, which will be held in Cleveland, Ohio, September 14, 15 and 16, simultaneously with the convention and exhibition of the American Society for Steel Treating, will cover a number of subjects, including gears, machine tools, sheet steel fabrication, gaging and inspection, heat-treatment, and training of foremen and mechanics. The technical sessions will be held at the Hotel Winton, which will serve as the society's headquarters in Cleveland.

James B. Dillard, general superintendent of the Cleveland Twist Drill Co., will present a paper on "Bringing Machine Tools up to the Level of Cutting Tools." L. L. Roberts, of the Packard Motor Car Co., is expected to discuss the subject "What is Needed by the Industry in the Way of Machine Tools?" At the session on gaging and inspection, C. E. Johansson, the well-known originator of the Johansson precision gage-blocks, who is now connected with the Ford Motor Co., will present a paper bearing upon precision measurements. Louis Ruthenburg, general manager of the Yellow Sleeve Valve Engine Works, Moline, Ill., will present a paper on "The Training of Foremen," and Mrs. Lillian M. Gilbreth of the Frank Gilbreth Co., Inc., will speak on "Training Employes in Production Work." P. L. Tenney, engineer of the Muncie Products Division of the General Motors Corporation, will present a paper at the gear session. At the same session papers will also be presented on spiral bevel gears and on rear axle housings.

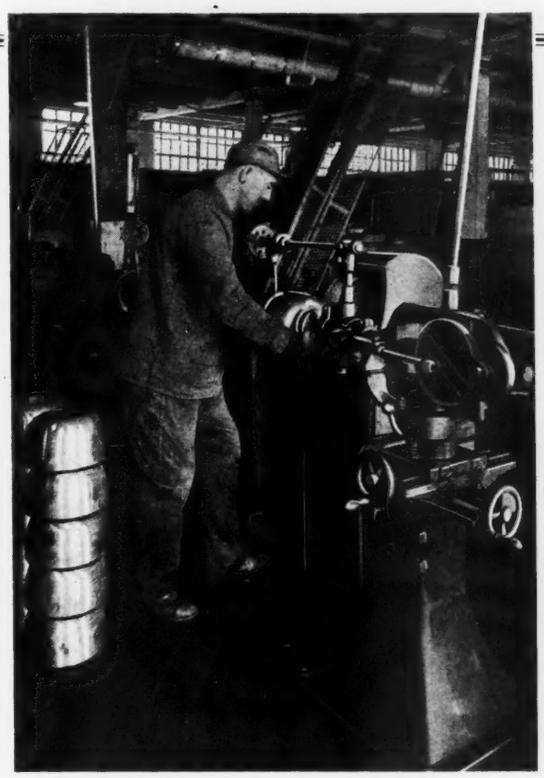
In connection with the meeting an exhibit of heat-treatment equipment, steel, and machine tools has been staged in the Cleveland Public Auditorium by the American Society for Steel Treating. The total number of exhibits will be about 170. Nearly one hundred of the exhibits will relate to machine tools, small tools and shop equipment. It is expected that the exhibition will be the largest held so far by the Society for Steel Treating. Both of the exhibition floors of the Cleveland Municipal Auditorium will be occupied. The exposition will open daily, September 14-19, from 1 p. m. to 10 p. m., except Sept. 17, when it will close at 5:30 p. m. on account of social features in the evening.

Technical sessions will be held by the Society for Steel Treating in the forenoon of each day beginning at 9:30 a. m. at the Hotel Cleveland, and in the afternoon of each day beginning at 2:30 p. m. at the Hotel Hollenden. The papers at the meetings will deal chiefly with the composition and treatment of steel and the equipment required for heat-treatment. Among over thirty papers to be read, the following may be mentioned as of especial interest to a large number of MACHINERY'S readers: "Effect of Reheating on Cold Drawn Bars," by S. C. Spalding, Halcomb Steel Co.; "Effect of Cold-work on Endurance and Other properties of Metals," by D. J. McAdam, Jr., U. S. Naval Engineering Experiment Station; "What Happens When Metal Fails by Fatigue," by Prof. H. F. Moore, University of Illinois; "Why Cast Iron and Steel Cracks and Warps," by John F. Keller, Purdue University, and a symposium on hardness testing. A special session will be held by the Machine Shop Practice Division of the American Society of Mechanical Engineers, at which will be read a paper on "Modern Surface Grinding," by Henry K. Spencer, of the Blanchard Machine Co., Cambridge, Mass., and another on die-sinking, by J. F. Keller, of the Keller Mechanical Engineering Corp., Brooklyn, N. Y.

Automatic Buffing Methods

Methods Employed in Buffing Oval Square and Other Irregular Objects and a Few Additional Chuck Designs—The Last of Four Articles

By CHARLES O. HERB



IN the preceding article of this series dealing with the buffing of parts automatically in machines built by the Automatic Buffing Machine Co., Buffalo, N. Y., the construction of a reciprocating type of machine was described, together with a number of work-holding chucks. Additional examples of chucks used in the same machine will be shown in the present article, which concludes the series.

Fig. 3 shows a brass teapot having twelve flat surfaces around its periphery. With this part, a loose wheel is used, the work being applied to the wheel at an angle, as shown by lines *Z*. In the experimental stages of this operation, it was found that the flat surfaces near the corners that reached the wheel first could not be given a satisfactory polish, but this difficulty was overcome by running the part through two operations. The second operation differs from the first only in the direction in which the work is rotated. In each operation, the production per hour is 40 pieces per machine.

Chuck *A* is shaped to suit the inside of the work, and is equipped with a bushing *B* into which a shank on handle *C* is inserted. The bushing is provided on both sides with bayonet slots which are engaged by the ends of a pin driven through the shank of handle *C*. Hence, by inserting the handle for the full depth and giving a slight twist to it, the work is locked on the chuck body.

Holding a Part by Gripping Internal Threads

There are many pieces of work that the ordinary mechanic would consider impossible to hold satisfactorily for buffing automatically. For example, on the part shown in the chuck in Fig. 1, the only surface that could be used for gripping the part is threaded. It would be impractical to screw the work on a threaded chuck because of the time that would be required for loading and unloading; however, the threads of the work are used by incorporating in the chuck three jaws *A* which have threads on the outer side of the forward end. These jaws pivot on pins.

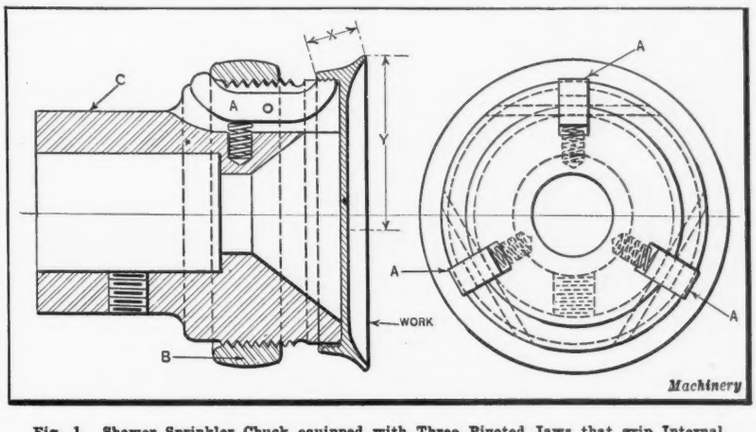


Fig. 1. Shower Sprinkler Chuck equipped with Three Pivoted Jaws that grip Internal Threads on the Work

In order to load a piece, nut *B* is screwed forward on body *C*, which permits a small coil spring under each jaw *A* to push the rear end of the jaw radially outward, and the front end toward the center of the chuck. Then, with the work held against the front of body *C*, nut *B* is screwed back, and as it comes in contact with the jaws, it swings the rear ends in, and the outer ends out into contact with the threads in the work.

Two operations are performed on this part, one with the work applied against the wheel as represented by lines *X*, and the other with the work against the wheel as indicated by lines *Y*. This part is a shower sprinkler, and has many fine holes through the surface buffed by wheel *Y*. As a heavy pressure against the work would result in the wheel dragging in these holes, a light pressure is used, and the work rotated for a longer period of time than is customary with a closed surface. The production on each operation averages 80 parts per hour per machine.

Chucks for a Reflector and Cover

Three operations are performed in buffing the copper reflector in the chuck shown in Fig. 2. This part is 12 1/2 inches in diameter and about 2 1/2 inches deep. In the first operation, the buffing wheel seats on the bottom of the concave surface, and in the second operation it is tangent with the same surface but operates near the outer end. The third operation consists of "coloring" the concave surface by hand. With two machines and two men, about 800 reflectors are completed per day.

Here, again, three swinging jaws are used to hold the part in the chuck, but in this example they grip on the periphery, which is cylindrical for a width of about 3/8 inch. The inner end of these jaws *A* is held in a groove running around a horizontally sliding member *B*, which is mounted on the hub of the chuck body. This member is moved

forward by means of handle *C*, causing the jaws to rise from the work, so as to permit reloading. When the handle is released, four coil springs *D* force part *B* back, and cause the jaws to grip the new part. Small tool-steel hardened plates attached to the jaws do the actual gripping. It will be noticed that the entire surface buffed is well backed up by the chuck casting *E*.

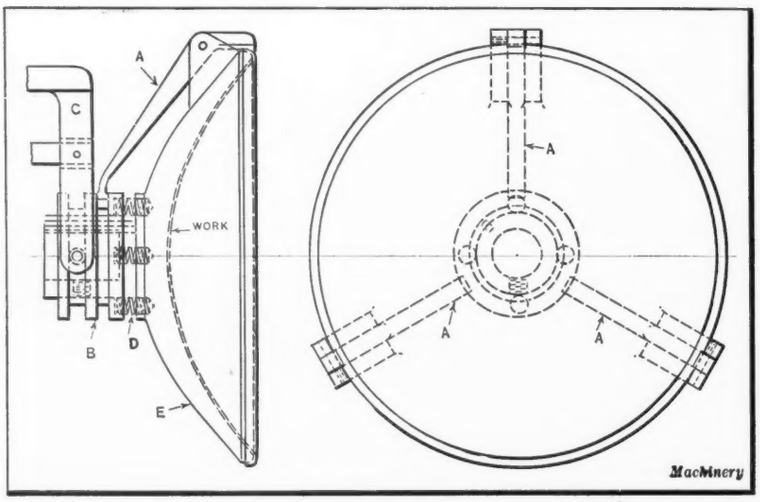


Fig. 2. Method of holding a 12-inch Copper Reflector while buffing the Reflecting Surface

The same type of chuck is used for holding parts having a convex contour, as shown in Fig. 4. Practically the only difference between this chuck and the one just described is the shape of the work-holder *A* and the dimensions of jaws *B*. In this case, the jaws are made of machine steel and cyanide-hardened, so that they need not be fitted with tool-steel plates. The work is an aluminum cover 6 inches in diameter. It is buffed as indicated by the dot-and-dash wheel lines at the rate of 90 pieces per hour per machine.

* * *

WORLD AUTOMOTIVE CONGRESS

The National Automobile Chamber of Commerce, 366 Madison Ave., New York City, has announced that a second World Motor Transport Congress will be held in New York January 11 to 13, 1926, at the same time as the National Automobile Show. Assurances of participation in this World Congress have already been received from fifty countries, speaking sixteen different languages. The National Automobile Chamber of Commerce is in charge of the arrangements. The first World Congress was held in Detroit in May, 1924. The congress is conducted on the basis of exchange of experiences. American manufacturers hope to learn a great deal from the visitors from abroad, and in return they will provide complete exhibits for their information. The meeting will be open to dealers, manufacturers, engineers, and others in foreign countries who are interested in the American automobile industry. In view of the fact that during the first six months of this year more than 260,000 American cars and trucks were shipped abroad—a record far exceeding any previous export business—and in view of the development of automobile building abroad, it is believed that the congress will be well attended and of considerable value to the industry.

* * *

PATENT OFFICE MODELS TO BE SOLD

From the first days of the Patent Office of the United States until 1880, the law required that all applicants for patents must submit a model of the invention with the application. As a result, the Patent Office has 155,000 models, including those of such outstanding inventions as the Bell telephone and the Howe sewing machine. It is estimated that it has cost the government $200,000 to take care of this collection since 1884, and it has now been decided to dispose of these models. Only those of historic or other value will be preserved, and the rest, unless previously applied for, will be destroyed or sold.

* * *

The automobile bus is not merely a competitor of the electric street car in urban transportation. It also serves a large undeveloped territory that the electric cars have never reached. Out of a total of 1832 cities and towns in California, 786, or nearly 43 per cent, are served by bus lines and have no other means of city transportation.

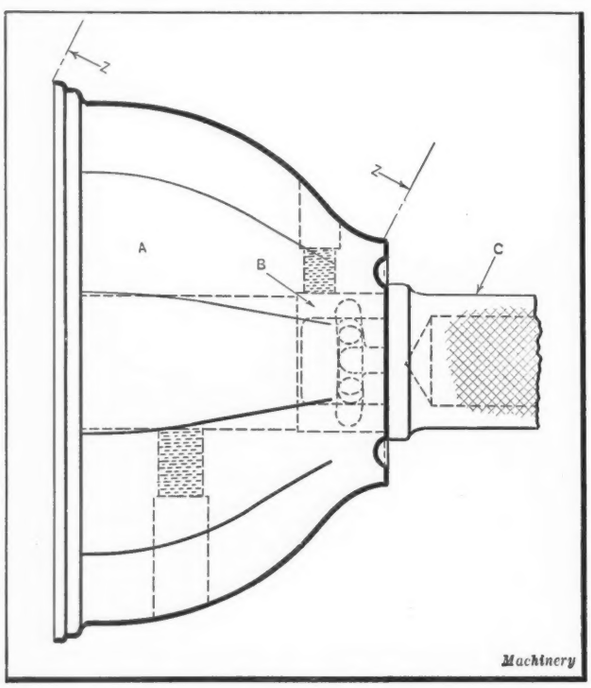


Fig. 3. Chuck with Bayonet Type of Lock used in buffing a Twelve-sided Teapot

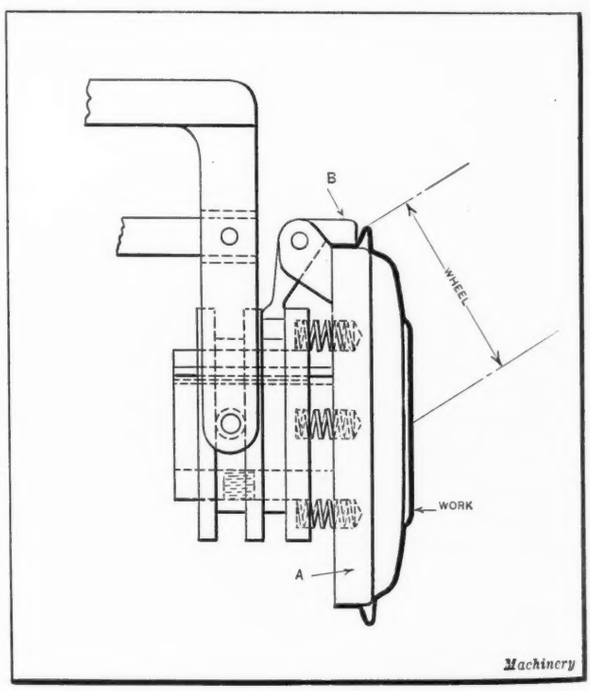


Fig. 4. Chuck of the Same General Design as that illustrated in Fig. 2 but for a Convex Part

High-speed Cutting of Brass*

By LUTHER D. BURLINGAME, Industrial Superintendent, Brown & Sharpe Mfg. Co., Providence, R. I.

QUESTIONS relative to operating on soft metals bring such varied answers that the conclusion must be reached that there is as yet no standardized practice. This seems to be especially so in making use of general-purpose machine tools and adapting them to high-speed work of this character. Some of the questions raised are: (1) The type of machine suited for the work; (2) the kinds of tools and methods of tooling, including whether carbon or high-speed steel should be used; (3) the kind of coolant, or the question of cutting dry; (4) the kind of metal to be used, the comparative cost between steel and brass, and the variation in the cutting qualities of soft brass; and (5) skill of lay-out men and operators.

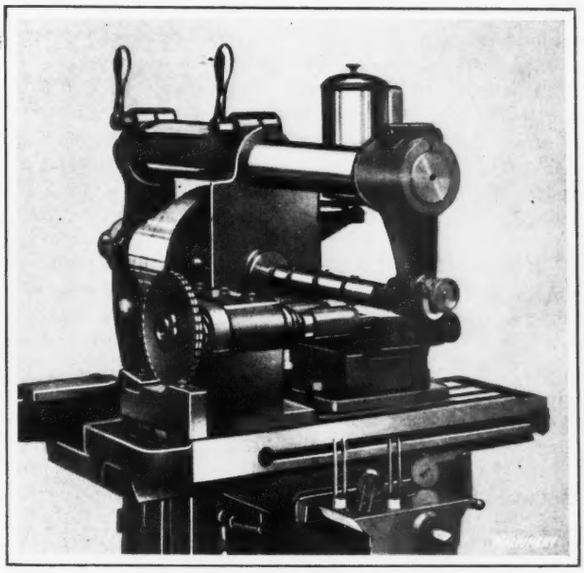


Fig. 1. Cutting 108 Small Brass Gears at One Time on a Milling Machine

Types of Machines

Many factors must be taken into consideration in determining the machine to use and the most efficient means necessary to obtain the maximum production. It is essential that it be possible to run the spindle at high speeds and to secure proportionally increased feeds. Tools must be so rigidly supported that they will stand the higher feeds and speeds and still produce smooth and accurate work without the necessity of too frequent grinding. The higher the rate of production, the more important becomes the saving of idle time. This is noticeable not only in screw machine, but also in milling machine work. In semi-automatic machines, where loading can be done simultaneously with the cutting, and the time of loading can be kept within the time of cutting, this idle time can be eliminated.

In a machine made primarily for high-speed work such as the Brown & Sharpe No. 19 automatic screw machine, the regular spindle speed is 5000 revolutions per minute. (Distinctive features of this machine were described in an article by the author in March, 1923, MACHINERY, under the title, "Screw Machine Products Made in Less than Three Seconds"). Drilling or other auxiliary speeds can be increased materially above this by running the drill spindle in the opposite direction at 3350 revolutions per minute, giving a net speed of 8350 revolutions per minute. For tapping and threading, the differential speed obtained by running the tap or die in the same direction as the spindle, is made use of.

The timing of the cams on this machine is such that the cycle of operations can be completed in two seconds, but that does not mean that this is the minimum time for completing a piece, as it is possible to use more than one set of lobes on the cams and in such cases to complete two or more pieces at each revolution of the driving shaft. The indexing of the turret can often be avoided, thus reducing idle time. The use of a swing stop when feeding the stock makes unnecessary the use of a turret station.

Much might be said of the comparative merits of single- and multiple-spindle machines for this type of work—each having advantages under certain conditions—taking into consideration the relative investment, floor space, idle time for changing the work, repairs, etc.

The use of attachments makes it possible to perform many operations that would otherwise make necessary a second handling of the work in another machine. As such operations are usually coincident with the primary operations, no extra time is required. Attachment work includes milling, cross-drilling and gear-cutting operations. Hand milling machines, such as those built by the Pratt & Whitney Co. or the small-sized automatic or semi-automatic milling machines now on the market, but specially speeded up for this work, are well adapted to such needs.

Tools to Be Used

Generally speaking, the same styles of cutting tools, but provided with less clearance, are used when cutting soft metals as when operating on steel. This is not always the case, however, as rolling threads on soft metals is a common practice and sometimes can be used to marked advantage. It is possible also to use skiving methods, which are especially effective when operating on aluminum.

As to the comparative use of carbon and high-speed steel tools, there seems to be a difference of practice, there being those who claim that carbon steel tools can be used with as good success as high-speed steel tools when cutting on soft metals, thus saving the greater expense of the latter. In the case of many screw machine jobs the diameter of the work is so small that the surface speed of the cut is below the maximum, and the cheaper carbon steel tools can be used without question. When high-speed steel tools are used without grinding they may not give as smooth a finish as carbon steel tools.

Kind of Coolant—Cutting Dry

While much work in cutting soft metals, especially in milling, is done without the use of a coolant, and tools will stand up surprisingly well under such conditions, the general practice is to use some coolant, usually lard oil. Even those who make a practice of using lard oil exclusively, admit that it is not only much more expensive, but is not so satisfactory a coolant as some of the soda-water preparations. The difficulty in the use of soda water is that it penetrates to the bearings and enters between the slides of the machine, resulting in hard action and breakage, a difficulty which does not exist when oil is used. There are, however, those using special soda-water solutions as coolants who claim that their mixture is such as to avoid this difficulty and give them the benefit of low cost combined with more satisfactory results. A coolant which gives good

*Abstract of a paper to be read at the meeting of the Machine Shop Practice Division of the American Society of Mechanical Engineers to be held in New Haven, Conn., September 8 to 11, 1925.

results in machining aluminum is made by mixing equal parts of kerosene and lard oil.

Kind of Metal to Be Used

Although steel costs but approximately one-third as much as brass, the much greater speed in machining the latter often makes possible such an increase in production that the question of initial cost of the stock is not only offset but a material reduction in cost results from using the more expensive metal. An important factor to consider is the salvage of scrap, which is so much greater for brass than for steel that often the labor cost of making brass parts can be paid for out of the sale of the scrap. Many brass pieces are made not only at a much lower direct cost than if made of steel, but there is also a material saving in the floor space and overhead charges, because fewer machines and shorter time are required.

One of the questions in determining the cost of making parts of brass is the quality of the brass stock used. It is claimed that there is a material difference in the working qualities of various brands of soft brass. For example, brass rods made abroad are as a rule harder and cannot be worked as readily as similar stock made in this country. This means that in setting up jobs to work the harder brass, slower feeds and speeds may be necessary and the use of high-speed steel tools needed.

It is economical to use tubing for some work made on the screw machine, although tubing as a rule is somewhat harder than brass rods; this must be taken into consideration in determining the economy of its use, as well as the higher cost per pound of the stock.

Skill of Lay-out Men and Operators

Where there are so many conditions involved and where the variety of work is almost infinite, long experience and special skill in devising the best ways of doing the work and determining upon what machines it can be most economically handled in, are of greatest importance. It is sometimes found that even after expert tooling up of a job that seems to be the last word in high-speed production, another method can be suggested that will give higher production and as good, if not a better quality of work. The alertness and skill of the operator in keeping his machines going and in bringing out the maximum production are likewise determining factors in securing satisfactory results. It is customary to allow a reduction of 10 per cent from the maximum continuous output to provide for the ordinary contingencies that arise, although it will be understood that this amount varies, depending on the conditions.

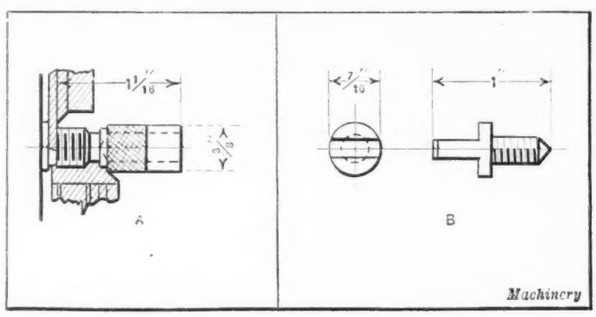


Fig. 2. Two Small Brass Pieces manufactured at High Rates of Production

Examples of Work

The paper then gives twenty-one miscellaneous examples of brass parts made in screw and milling machines and three examples of high-production gear cutting in small plain milling machines equipped with special attachments. Speeds, feeds and production figures are given with each example, together with interesting comments. Several of these examples will be given here.

Example shown at A, Fig. 2. An example having a threading operation which in order to be produced without a second handling must have the thread rolled. This is a job done on the Brown & Sharpe No. 00 automatic turret forming machine, with the spindle speed at 5000 revolutions per minute, but without the fast drive shaft. It is not practical to use the fast drive shaft on this job because the turret traverse must then be reduced to 5/8 inch so that it is not practical to drill deeper than 1/2 inch and the hole in this piece is 5/8 inch deep. This gives a surface speed for forming of 500 feet per minute; time, 5 seconds. The thread is rolled by a top-thread roll holder, held in conjunction with the cut-off tool.

What are the advantages of rolling threads? Thread rolling avoids the reversing of the spindle and makes it possible to complete many parts that otherwise would require a second handling. For instance, were this piece made from steel it would be necessary to rechuck it to perform the threading operation.

Example shown at B, Fig. 2. This piece is made in the screw machine up to the point of milling the flats which is done on a Brown & Sharpe No. 0 plain milling machine, using a semi-automatic attachment. With the spindle running at 700 revolutions per minute, 500 pieces per hour can be produced on this machine. The direction of the cutters is such as to feed on to the cut, and the cutting is done dry. In this case the cutters are made without side clearance, in fact, with a slight drag to the teeth so as to produce a smooth finish, practically without a burr.

This same piece, milled on the Brown & Sharpe No. 21 automatic milling machine running at the same spindle speed as above, can be produced at the rate of 600 pieces per hour. In this case the loading is done during the time of cutting, and the difference of 100 per hour in the number of pieces between the product of this machine and the machine previously referred to represents the time thus saved. Although cutting dry, 45,000 pieces can be machined between grinds when using high-speed steel cutters.

Fig. 1 shows the cutting of brass spur gears 1/16 inch thick having 42 teeth of 30 diametral pitch, that are strung together in gangs of thirty-six. The use of triple index centers makes it possible to cut three strings at one time, making a total of 108 gears. The automatic feed of the milling machine at 0.030 inch per revolution is used for this job, but the return motion is by hand. After the cutters are clear of the work the index operates automatically by means of a cam plate back of the table. The cutters are 2 1/4 inches in diameter and run at a spindle speed of 1000 revolutions per minute, giving a cutting speed of 580 feet per minute. The time for completing each gear is 5 1/3 seconds.

While the examples are limited largely to a particular line of machines, they are nevertheless typical of the problems which may arise and the methods of handling work. It is believed that enough of them are given to indicate that special study of each particular job will point the way to improved time-saving methods and eventually lead to the adoption of the best.

* * *

STEEL AND MALLEABLE CASTINGS

In the steel and malleable castings field there has been a slight drop in production as compared with the earlier months of the year. Since January 1, production of malleable castings has averaged between 50 and 60 per cent of capacity. In the steel casting field, the output is now below 60 per cent of capacity, while it exceeded this figure in January, March and April. There is always, however, a decline in these lines of business during the summer months, and it is well worth noting that the output in June, the last month for which complete statistics are available, was 60 per cent above the output of the corresponding month in 1924 in the malleable casting field, and 40 per cent greater in the steel casting field. Furthermore, the producing capacity of both steel and malleable castings is considerably greater than necessary to meet a "normal" demand.

Observation of High-speed Mechanisms

Use of Apparatus that Causes Rapidly Moving Parts to Appear Stationary at Any Point in the Cycle of Movements

By PETER DAVEY

THE modern tendency in the design of machinery of all kinds is increase of speed. This refers alike to production operations and to operating machines, and it necessitates a much fuller knowledge of the behavior of machinery under working conditions than was the case when lower speeds prevailed. The reason for this is that inertia effects become increasingly troublesome with higher speeds, causing automatic machines to jam, valves to function incorrectly in engines, threads to break in textile machines, and parts to vibrate so that it is impossible to run some machines at certain speeds.

The few examples mentioned indicate that the troubles are widespread in many fields of engineering, and almost any engineer can think of a number of cases in which the increase of speed has led to trouble. If, however, the exact cause of the trouble could be located by some simple means, it is safe to say that a great deal of time and expense could be saved in adjusting the operation to the new conditions of working.

Use of "Slow Motion" Pictures

Various means have been used for the motion study of high-speed mechanisms. Perhaps the most familiar form of motion study is by means of the ultra rapid or "slow motion" moving picture, in which photographic exposures are made at a very high rate of speed, and projected on the screen at the normal rate of about sixteen pictures per second. This method has been successful in many cases where no other means could have been employed, and gives an accurate picture of what is actually happening, but in industrial work it has decided limitations.

In the first place, a motion picture camera must be handled by a skilled operator, and special lighting is required in order to produce good results. The film travels through the camera at very high speed, and it is expensive; in a number of cases that have been brought to the attention of the writer, some hundreds of feet of film have been wasted before the machine under examination could be caught in just the right phase of its operation. Furthermore, the ordinary type of portable moving picture camera is not rapid enough for many of the jobs to which it has been applied, although special types have been evolved that are many times more rapid.

Stroboscopic Principle

The alternative to the moving picture is the stroboscopic principle. This principle dates back many years, and is well known in scientific fields, but there have been few commercial applications of it. This is probably due to the fact that there have been a number of practical difficulties in the way of producing a really good stroboscope.

The main difference between the "slow motion" moving picture and the stroboscope is that with the former, the result is attained by examining a picture of the mechanism, while with the latter, the observer looks directly at the mechanism. The stroboscopic effect is obtained by interrupting the vision between the observer's eye and the mechanism in such a way that he gets a quick glimpse of the mechanism each time it reaches a certain point in the cycle of operations. The result of this quick succession of glimpses, at the same point every time, is that the mechanism will appear absolutely stationary at that point. The explanation of this is that during the brief period of each glimpse, an impression is made on the retina of the eye, which will remain until it is followed by the next glimpse, the whole succession of glimpses being woven into a continuous picture; this phenomenon is known as "persistence of vision."

The earliest form of stroboscope consists of a disk with a single hole in it, the disk being rotated in front of the mechanism to be examined, and at the same speed as the mechanism. Once every revolution the hole will come in the line between the observer's eye and the mechanism, giving the stationary effect. Another method of interrupting the vision is by means of a vibrating reed, such as the limb of a tuning fork, with a shutter on the end of it, the reed being maintained in vibration electrically at the same frequency as the rotation of the mechanism under observation. It will be readily appreciated that in order to obtain a clearly defined stationary image, the duration of each glimpse must be extremely short, as otherwise the mechanism will have time to move an appreciable amount during the actual period of observation.

Illumination of Moving Parts by Succession of Rapid Electrical Flashes

The chief difficulty in the way of mechanically interrupting the vision, as outlined, lies in obtaining a sufficiently rapid glimpse. Suppose instead of actually interposing something between the eye and the mechanism, we illuminate the mechanism by a succession of rapid electrical flashes; then we shall obtain the same result, with the advantage that the periods of illumination may be much shorter; moreover, since it is not necessary to look through an aperture, the operation is far more comfortable and convenient.

High-power spark discharges across an air gap, and discharges in vacuum tubes, have been used to produce stroboscopic flashes, the latter being far more convenient to work with, but the design of a vacuum tube that gives sufficient light for practical purposes, and at the same time a short enough flash, has been a source of difficulty. Such a tube has been developed, however, and it is an important part of the "Vibroscope" which is adapted to the study of rapidly moving parts in order to see how they function while operating at the required speed. The "Vibroscope" (which has been developed by the writer and introduced by E. M. Sawtelle, 11 Broadway, New York City) is equipped with a

special Neon tube of unusual design, which gives illumination far in excess of that ordinarily obtained in any vacuum tube, and at the same time, the flash is of extreme rapidity, while three dry cells provide the only source of power for its operation.

Arrangement of the "Vibroscope"

The "Vibroscope" consists of a lamp containing the Neon tube, means of supplying the electrical discharges to illuminate the tube, and a device for regulating the flashes of light in synchronism with the movements of the mechanism under examination. The lamp has a spherical reflector containing the tube *A*, Fig. 1, which screws into a standard socket, mounted on a convenient handle on the end of a flexible lead, so that it may be carried around to illuminate any portion of the mechanism. The discharges are produced through the medium of a specially designed induction coil *B*, which draws its power from three dry cells or two storage cells. The light flashes are controlled by an interruptor at *C*, which is preferably driven direct from a shaft of the mechanism under observation (as the illustration shows) so that the flashes will automatically be in synchronism with the movement of the mechanism.

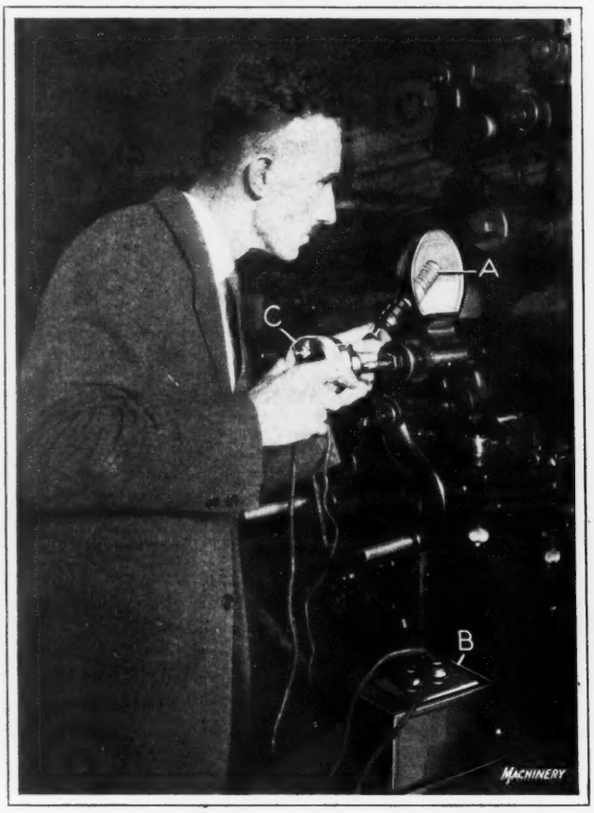


Fig. 1. Studying Action of a Mechanism by Means of the "Vibroscope"

In designing the interruptor, the general lines of an ordinary hand tachometer were kept in mind as far as possible, since in this form we have an instrument that can be readily applied. Rotary movement is imparted to the shaft of the interruptor through the medium of a steel or rubber driving point *D*, Fig. 2, which is held in contact with the center on the shaft of the machine under examination; or if necessary, a direct coupling may be arranged. A cam is mounted on the interruptor shaft which operates a contacting device. The interruptor is in two parts, one of which may be rotated concentrically upon the other. On turning the outer part, the timing of the flashes is changed; thus if it is turned in the direction of rotation, the machine will appear to move forward when viewed under the rays of the light, and similarly, if it is turned in the opposite direction, the machine will appear to rotate backward. Hence the machine may apparently be brought to rest in any desired position in the cycle of operations.

A scale at *E*, marked in degrees upon the rotatable portion, enables the observer to obtain actual quantitative results regarding the angular relation of the points of observation. A further refinement is an adjustment making it possible to vary the number of light flashes per revolution, the function of which will be described later.

When the switch is turned on, the light will flash at the same speed as the rotation of the shaft, and any of the moving parts of the machine that are brought under the rays of the light will immediately appear stationary, irrespective of whether the motion is rotary, reciprocating, or vibratory, provided the drive for the interruptor is rotary. Direct rays of daylight from a window may cause some inconvenience, but screening of these rays is all that is necessary. The stationary effect is absolute, and it is often difficult to imagine that the machine is actually moving. The reason for the stationary effect is that the light flashes are in exact synchronism with the rotation of the shaft.

A general idea of the speed range of the "Vibroscope" may be obtained from the following applications, which represent the highest and lowest speeds to which it has been applied up to the present time. The highest speed is that of a saw running at 12,000 revolutions per minute, and in this case, every tooth showed up with great clearness, even down to minute scratches on the metal, and the exact form of the shavings could be observed with ease. It was evident that the speed in this case was considerably below the ultimate range of the instrument. The lowest speed so far has been 40 revolutions per minute. This was in connection with a research problem on rubber tires, and at just one point in the revolution, a very quick movement took place. This movement not only showed up clearly, but satisfactory photographs were taken under the rays of the light.

It will be apparent that above a certain speed it is impossible to distinguish between the individual flashes, that is, the flashes are woven into an absolutely continuous picture. It is difficult to determine definitely the lowest speed at which the "Vibroscope" flashes appear continuous, because the human element enters into it, but 500 revolutions per minute would appear to be a safe estimate. Many of the applications have been far below this speed, and the fact of the flashes being separated, does not prevent the instrument from functioning, but a little additional precaution is usually necessary to screen off the direct rays of daylight.

Examples Illustrating Use of "Vibroscope"

In the application of the "Vibroscope" frequently wholly unexpected results are revealed, and a trouble that was supposed to come from one source will be shown to originate in another direction altogether. In one case, the writer has actually seen the valve of a high-speed internal combustion engine bounce three times before coming to rest on its seat, when the engine was turning over at about 2300 revolutions per minute. In another case, the valve springs were surging so badly at high speed that at one position the spring compressed itself so that it was not touching its normal point of contact at either end; that is, the motion could be arrested so that the spring appeared to be suspended in mid-air. Engine valve gear is typical of the many problems encountered where high-speed cam motions are concerned, and not only is it possible to observe when a follower is leaving a cam due to the inertia, but it is also possible to measure accurately, in degrees on the scale *E*, Fig. 2, the extent to which this jump is affecting the dwell of the cam, or in the case of an engine, the timing of the valves.

Determining Lubrication Troubles

Problems involving the lubrication of rapidly moving parts have occasionally shown results that were wholly unexpected. One of the most surprising features in the behavior of lubricant under certain conditions is the exactness with which it will repeat its cycle at every revolution of the machine. That is, supposing we have a moving part that

is throwing off globules of oil at every revolution: the "Vibroscope" light will reveal a train of globules standing perfectly still in mid-air, showing that at every revolution the globules reach the same point.

An unusually interesting problem involving lubrication was the case of a pair of helical gears. There was a complaint that a number of sets of these gears were developing noise after having run a comparatively short time, and careful checking up of the cutting and mounting failed completely to show any reason. Application of the "Vibroscope," however, made the cause immediately apparent. These gears were lubricated by a plunger pump running at the same speed as one of the gears, and therefore, pulses of oil were alighting on the same point on this gear every revolution. It was immediately seen that the oil was hitting on the top of a tooth every time, rolling across the tooth, and being flung off before it had a chance to get down into the mesh. Hence these gears were running practically dry, and the cause of the noise was obvious.

Examination of the gears with the naked eye, while running, revealed nothing, as they appeared to be surrounded by a mist of oil, and there was no reason to believe that it was not getting down into the mesh; also, on stopping the machine, the gears were always well covered, since in the process of stopping, they ran through a speed at which the oil was no longer thrown off. The trouble was quickly rectified by making a slight change in the direction of the delivery pipe.

The cause of troubles in automatic machines have sometimes been shown to lie in entirely different directions than was originally suspected, and application of the "Vibroscope" has saved a great deal of unnecessary work by locating the seat of the fault. Problems have come up on several occasions connected with machines that have been designed to work at a certain speed, but that have commenced to give trouble before that speed was reached. In cases of this nature, if the speed is gradually increased while observations are being made, the trouble can be caught in its early stages and the means of rectifying it will often become apparent. By following this line, in some cases, the production of machines has been actually increased beyond the designed speed.

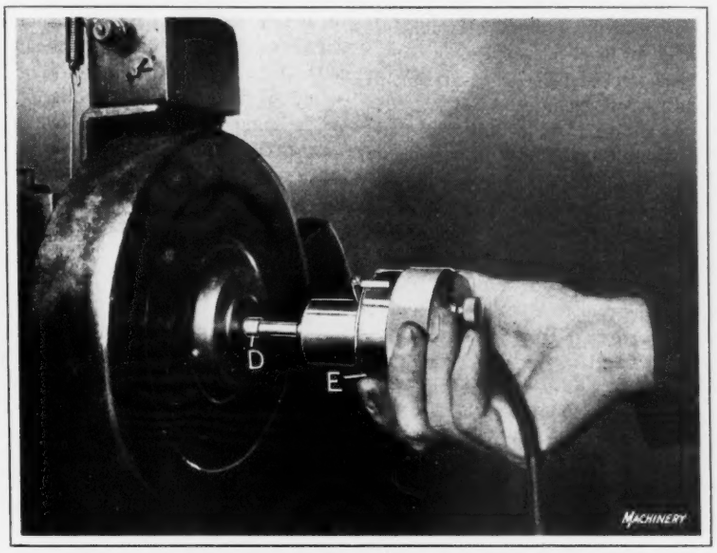


Fig. 2. The Interruptor, the Shaft of which is held against the Rotating Part

Locating Cause and Extent of Excessive Vibrations

The applications of the "Vibroscope" may be divided into two classes—namely, pure motion study and vibration analysis. Of course, vibration analysis is itself motion study, but in most cases it is a factor that is known to exist, and what is required is a quantitative analysis, while in the examples of motion study such as have been referred to, it is often a case of looking for an unknown condition.

To aid in the analysis of vibrations, a special feature is incorporated in the interruptor, which makes it possible to change the frequency of the light flashes. Suppose we have a part of a machine that is set in vibration by a shaft from which the interruptor is being driven. Now by throwing the rays of the light upon the vibrating part, its motion will be apparently arrested in the same way as that of any other kind of motion, but this will not aid in determining its amplitude or direction, because it will probably be of small amplitude, and we have nothing to compare it with.

However, if we illuminate it with flashes at twice its frequency, then the interruptor can be set so that the vibrating part is viewed simultaneously in its two extreme positions; in other words, we shall have a double image of the vibrating part, and from the distance apart of the two images, we can obtain a measurement of amplitude. The interruptor is therefore arranged so that there is normally one light flash per revolution, but by a simple adjustment, two flashes per revolution may be obtained. For special cases any number of flashes per revolution can be arranged for.

The usual procedure is to scribe fine cross-lines on the vibrating part, or in cases where the amplitude is small, to mount a small white disk with black cross-hair lines, securely on the vibrating part. To take a simple case, suppose we wish to determine the amplitude and direction of vibrations of the bearing of an electric motor. A disk is mounted in a convenient position on the top of the bearing cap, and the interruptor is driven from the motor shaft, the rays of light being directed upon the disk.

Now if the vibrations are at shaft speed, a double image of the lines will be apparent, and changing the angular setting on the interruptor scale will cause the two images to approach or recede from each other, while the setting may be held in any desired position. Consequently, if the adjustment is held at the point where the two images of the line scribed in the axial direction are at their maximum distance apart, we get a measurement of the transverse amplitude; then, turning it on until the same condition applies to the line scribed in the transverse direction, we have a measurement of the axial component of the vibration. In this way, complete information regarding the amplitude, direction, and periodicity of the vibration is secured.

Suppose in the case cited that the vibration had not been at shaft speed, but that the whole structure on which the motor was mounted, was vibrating at its own free period; then instead of seeing a stationary double image of the lines, a movement of the lines would be seen (not necessarily double) recurring in beats, proving at once that the trouble lies not in the motor alone, but also in the structure.

* * *

The Aeronautical Research Committee of Great Britain has recently made a report relating to the effect of keyways on the strength and stiffness of shafts. The subject was investigated with a view to determining, by actual tests, whether the effect of keyways on shafts is in accordance with the results obtained by calculation. It was found that there was a reduction of 23 per cent in the elastic limit of the shafts tested, as compared with plain shafts without keyways. This result harmonizes quite well with the theoretical results. The ultimate strength of a 65 per cent carbon steel shaft was reduced 21 per cent, as compared with the theoretical value of 24 per cent. A shaft of very low carbon content was also tested. In this case, the elastic limit showed a reduction of approximately the same amount as the 0.65 carbon steel shaft, but the ultimate strength of the low-carbon shaft was reduced only 12 per cent, as compared with that of a plain shaft of the same material.

Current Editorial Comment

in the Machine-building and Kindred Industries

FACTS ARE BETTER THAN OPINIONS

In the foreword to the Commerce Year Book, just published by the Department of Commerce, Secretary Hoover points out that American industry is gradually being placed on a firmer basis. Wasteful practices are being eliminated and industry produces more efficiently—that is, with less expenditure of labor for equal results. In 1923 our output of manufactured products was 60 per cent more than in 1914, and the value, due to higher price levels, was about 150 per cent greater. The 60 per cent greater quantity was produced by increasing the number of the workers only 25 per cent; but the horsepower used in the industries was increased 50 per cent in the same period, indicating that mechanical power replaced man power to a large extent; more goods were produced with less effort and more goods were produced per man. Consequently, more goods were also consumed or used per capita, because industry produces only as fast as consumption continues. If consumption slows down, industry very soon must follow suit.

It is also of interest to note that in 1924, which was considered by many a rather dull year, the production was only 5 per cent less than in 1923—the record year in the history of the production of this nation. Furthermore, in 1924, production was 13 per cent greater than in 1919, which was considered a boom year in many industries. There is nothing the matter with the volume of output of our industries or with demand and consumption. The real fact is that we have increased our manufacturing facilities and our efficiency of manufacture to such an extent that all our available manufacturing facilities are not required to meet the present demand of the consumer, even though it is the greatest on record; for there is every indication that 1925 will surpass 1923 in volume of production.

* * *

WORTH-WHILE CONVENTION PAPERS

Within the next two months many trade associations and engineering societies will hold their fall meetings. Many papers will be read—some good, some of indifferent value.

No matter how diligently the executive committee of the various associations and societies endeavors to secure the highest grade of papers to be presented before the meetings, it is always difficult to prevent some from being of mediocre quality. If the authors of papers to be read before conventions would keep in mind a few fundamental rules, they could greatly improve their presentations, hold the interest of their audiences, and add more valuable contributions to the proceedings.

First, avoid lengthy papers. Deal with a subject briefly and concisely, and make it a point to have each sentence express a definite idea or convey some specific information. Avoid long introductions, especially those that describe in detail how the author happens to be familiar with the subject with which he is dealing, how he gained his experience, and what he thought and did on various occasions. Many a speaker loses his grip on the audience at the very beginning by an introduction that may be interesting to him, but that contains nothing of value to the listeners.

If the paper is technical in character and requires mathematical formulas for a complete treatment, do not repeat the formulas before the audience, because few can follow a mathematical deduction when presented in that manner. State merely that through a mathematical analysis certain conclusions may be reached, and give the conclusions in clear and simple language, leaving the mathematical treatment for the printed record of the convention proceedings.

At the end of the paper, make a brief summary of what has been said, so that the conclusions arrived at and the points it is intended to drive home may be clearly understood by the audience. Last, but not least, if you wish your paper to interest and benefit a larger audience than that present at the convention, do not fail to have a sufficient number of copies available for the members of the technical press attending the convention, so that it may obtain the wide publicity its value may entitle it to.

* * *

HARDNESS AND MACHINEABILITY

A special research committee on the cutting and forming of metals appointed by the American Society of Mechanical Engineers recently discussed a number of problems connected with the cutting of metals which confront the industry.

One of the members brought out the fact that, as yet, there is no commonly accepted measurement for hardness. The engineering profession has not settled what hardness is. Present hardness tests, it was stated, are suitable only for purposes of comparison, and while acceptable for commercial work, are not sufficiently exact for scientific research. It was pointed out that practically all the present methods for measuring hardness record the result of the action of a definite force upon the material tested, rather than the force required to produce a definite effect, which is the scientific method, and that for scientific research purposes, a hardness testing method should be developed that would measure the force needed to make an indentation of a given depth. More research is necessary in the hardness testing field, although great credit is due the pioneers who developed methods and devices with which satisfactory tests can be made in commercial engineering work.

A word frequently used and very much abused is "machineability." This is another case where engineers have not clearly defined the meaning of an important word. Good machineability is intended to convey the impression that the material can be easily cut; but we need a clear definition, commonly agreed upon, and also means for measuring machineability. At the committee meeting referred to, one of the members recommended that the word "machineability" should not be used until it has been clearly defined. It is one of those words that might prove very misleading.

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MONUMENTS

A monument of some kind marks the lives of most great men. It may not be a granite column or a bronze statue, for many of the outstanding monuments to great engineers are useful mechanisms and processes that represent important contributions to their profession.

Often the obituary columns of MACHINERY refer to such men, most of them little known outside of the locality in which they have worked for years in developing some principle or machine essential to industrial progress. Such results usually are not spectacular; to most people the professions are dry and the man who delves in them is not a popular figure. But future generations may have different standards and another kind of yardstick for determining the true worth of a man, with graduations based upon creative values. Until then the pioneers in industrial development, as well as those who have been perfectors rather than originators, may have only the useful monuments created by their own minds and hands. These will continue to be fitting tributes.

The Future of the Machine Tool Industry*

By O. B. ILES, President of the National Machine Tool Builders' Association, and President, International Machine Tool Co., Indianapolis, Ind.

THE engineering and designing skill and ability of the machine tool industry has made possible the development of every factory where metal must be machined. Without machine tools it would not have been possible to develop mass production of the articles that have contributed and are now contributing to our civilization. So it is quite natural that those engaged in the machine tool industry should inquire as to what the future has in store for them.

The development in machine tool design in the last twenty-five years has been rapid because of the rapid development that has taken place in the manufacture of metal products during that time. The machine tool designers have been guided by the requirements and demands of the users during that time. If the users demanded a tool for drilling, milling, turning, boring, or planing, the designer gave him the best that ability, skill, and experienced dictated. Tools that a few years ago were considered more or less special are now considered standard machines. This tendency is prevalent today, and it is reasonable to expect its continuance in the future. Mass production demands larger and more economic production. The advent of high-speed cutting tools demands larger, stronger, and more rigid machine tools. It is reasonable to surmise that the limit of cutting tools has not yet been reached, and that the future design of machine tools will have to keep pace with the development of cutting alloys.

Developments in Machine Tools Dictated by Growing Production Needs

The demand and requirements will always to a large degree dictate the design, quality, and productive capacity of machine tools. The machine tool designer and builder has had to keep in close touch with the needs and developments of the user industries. If more strength, more power, greater feeds and speeds, and more convenient operation were required by the user, the machine tool builder has had to comply with these requirements. Nor have the progressive machine tool designers and engineers waited for the user to suggest design. The progressive machine tool builders have foreseen most of the requirements and endeavored to supply the users accordingly. It is reasonable to predict that this condition will continue and that the cooperative effort on the part of builders and users of machine tools will grow stronger in the future.

Single-purpose Machines and Automatics will Play an Important Part

Some of the leading thinkers and doers in the machine tool industry and many of the largest users think that the demand for single-purpose machines, semi-automatics, and automatics will become more and more pronounced. Inasmuch as the trend in many lines of industry is toward concentration in large shops, and as there is a demand for lower and lower production costs, it is reasonable to forecast an increasing demand for more and more automatic machine tools. If quantities are large enough, this demand will be likely to lead to combination automatic machines, doing multiple operations of milling, drilling, boring, turning, etc., on one machine. This is being tried in a small way now. The opinions of builders are divided on the extent to which a machine of this type can be economically adopted. One leading machine tool builder says, "Experience has taught both the user and the builder that segregating operations tends to best workmanship and production. Combining operations leads to complications that lower production, due to care of tools and breakdowns." But with more application of inventive and constructive skill, who shall say that the machine tool designer will never overcome these present troubles?

While conditions point to the larger use of automatic and single-purpose machine tools in mass production shops, there will always be need for the so-called standard machine tools—engine lathes, drill presses, shapers, etc., not only in small shops, but in the large plants. As the automatics are further developed, the next decade will see a still further development in the standard tools, always meeting the requirements of the future cutting materials in strength and rigidity, and advancing over present designs in simplicity of operation, accuracy, and the maintenance of accuracy for the greatest length of time.

Changing Conditions in Labor Supply will Produce Greater Demand for Machinery

Until recently men willing to do manual labor have been plentiful, but this class of labor is decreasing and is becoming more and more costly. Many of our large manufacturers have been dependent to a great extent on immigrants for this class of labor, but our immigration laws are preventing these men from coming to us. If this class of labor cannot be had at a reasonable cost some substitute must be supplied. What is there except machinery, particularly automatic machinery to supply this deficiency and demand?

Until this time the industries using machine tools have been growing and expanding. New lines have come into existence, due to the demand of our people for more necessities and conveniences of life. The luxuries of yesterday are the necessities of today. During these periods of expansion, the methods of pioneers have prevailed, with too little regard for waste and refinement in manufacture. In ten or fifteen years from now our present methods, in many instances, will be considered too wasteful to tolerate.

We are Entering Upon an Era of Severe Competition

Many thoughtful business men, like A. Lincoln Filene, think we have entered on a period of most severe competition in manufacture and business, one requiring that costs be reduced to the minimum by mass production, by the introduction of every refinement and device that will save time and labor, and by the elimination of all waste in time and material. It is not difficult to forecast that those manufacturers who do not use the latest machinery, equipment, and methods, and who do not reduce the waste of time and material to the last degree, will sooner or later be eliminated.

Problems Peculiar to the Machine Tool Industry

During this period of severe competition, the machine tool designer, engineer, and builder will be in great demand for furnishing high-production machine tools. The same competition will enter into the machine tool industry. The machine tool builders will be compelled to look to the cost of their own products and their own shop efficiency and management more closely than in the past. The very latest equipment and methods must be employed by them as well as by their customers, to reduce cost and eliminate waste. However, owing to the conditions that have prevailed in this industry in the past, we do not see how it is possible

*Abstract of a paper to be read before the Machine Shop Practice Division of the American Society of Mechanical Engineers, at New Haven, Conn., September 9.

ever to introduce large production in a machine tool plant in the same way as in plants manufacturing articles for general consumption. The demand for machine tools will not permit of mass production. The call for special features in machines to meet specific requirements makes nearly every machine tool more or less a special machine and precludes large production.

The cost of carrying large stocks with the ever-present danger from obsolescence makes it too hazardous to manufacture for stock even the most standard of machine tools in large quantities. Furthermore, there is but limited demand for large quantities of any one type of machine tools. There are exacting requirements in regard to accuracy, and the continued maintenance of accuracy; there are suddenly recurring periods of little demand; there are always new designs, and the bettering of design and development of machine tools to meet ever-changing requirements. As in the past, we believe that in the future all these things will preclude mass production of machine tools.

The Large Organization as a Factor in the Future

In nearly all industries where an effort is made to get the product to the consumer at the lowest reasonable cost—to eliminate all the waste possible—there is evident advantage in combining small establishments into a relatively few large organizations, and thus reduce the overhead expense all along the line. While the machine tool industry operates under different conditions from most other industries, here, too, the trend is toward large and more powerful and efficient organizations. There have been some combinations of machine tool builders, and it is reasonable to expect this to continue.

Nevertheless, there will always be the small machine tool shop. There will always be mechanics and mechanical engineers who do not work best in a subordinate position, and who have worthwhile ideas and designs and sufficient persuasive power to get financial backing to build and market machines embodying their ideas. One of the great faults of large organizations is the submerging, and sometimes the loss, of individual responsibility and effort. Unless this individual effort is cultivated and maintained in any large organization, the utmost success will not be realized and failure is probable. The advantage gained by size and resources is more than offset by the lack of individual cooperative effort and interest. The future large machine tool organization must find a way to maintain this individual cooperative interest and effort.

Selling and Distribution of Machine Tools

One of the most important items for consideration in the machine tool industry is the method and system of distribution—the sales policy. If the method of getting the product to the consumer is inefficient, costly, or wasteful, either the manufacturer makes too small a profit or the customer pays for this waste. The method of selling machine tools used by most manufacturers has been through machine tool agencies or dealers. This is particularly true of the smaller and medium-sized manufacturers. Some of the larger concerns have sold their product direct to the users for years. The present tendency is more and more toward direct sales. This is particularly true of the large organizations and builders of more or less special machines. If we are right in our opinion that the machine tools of the future will be made by larger combined and concentrated organizations, it is reasonable to believe that there will be a tendency toward direct selling.

To be successful and efficient, the machine tool salesman of today must be grounded and trained in the design, purpose, efficiency, quality, performance, and productive capacity of the machine tool he is offering for sale. He must be able to advise intelligently the mechanical and financial departments of the prospective customer. The prime function in the marketing of machine tools today is education—showing the prospective customer the adaptability of the machine and methods to the particular work in question. Therefore, the salesman should have the ability to prove the advantage, in dollars and cents, of an investment in his particular tool. He should be able to show the prospect the loss he is daily sustaining because of the use of obsolete machines and methods. Salesmen of this type can best be trained by an organization that has specialized in a particular line in machine building.

Possibilities in Foreign Markets

So far we have had reference to the market for machine tools in the United States—the home market. The industrial development at home has brought forth designs and qualities to meet the demands for mass production, and because the home market has been large, the quality of design and workmanship has made the United States a world leader in the production of machine tools. Along with the care and further development of our home markets we must give even more attention than we have in the past to the world markets for machine tools. We must meet the competition of the world. We must be able to show that regardless of price, an investment in machine tools made in the United States will pay the largest dividends in quality and quantity production.

In most of the industrialized European countries, due to the cheap labor available, manufacturers have not been forced to use machinery instead of man power to the extent that we have in the United States. Nor have they undertaken mass production to the extent that we have. But this will come, and will come soon, and along with it will come the demand for rapid-production machines.

The Problems that Must be Solved

As our civilization becomes more complex, the problems encountered become greater. As every individual industry grows and expands, it becomes more complex. It has thrust upon it a proportionate amount of problems to be solved—problems that are general to the industry and that are apparently the business of no particular individual or concern, but are or should be the business or burden of the industry as a whole; problems that no one concern can do much to solve, but that can be quickly solved by the cooperative effort of all the industry.

The machine tool builders have many of these problems which they are endeavoring to solve through the National Machine Tool Builders' Association. One of these problems is to reduce the expense and loss caused by a periodic slack demand for machine tools. It is either a feast or a famine; the users wait until they must have the tool before they order. These slack periods compel the builder to break up his organization and take losses that must be made up in busy times, if he is to stay in business. This is a waste that we wish to overcome. We wish in some way to educate the user to buy his machinery more regularly, to forecast his needs better, and not swamp the machine tool builder with boom time orders. This is in the interest of economy, efficiency, workmanship, and price. The next decade should see a marked improvement along this line.

The Place of Second-hand Machine Tools

Another problem is the disposition of used tools. This problem is growing. A plan must be worked out whereby tools fit only for scrap will promptly go to the melting furnace, and the tools that have residual value can be allotted to places where their service will be greatest. While the machine tool builder is demonstrating that money and time and effort are being wasted by the use of obsolete machines, he must also be able to advise as to the disposition of displaced obsolete machines. It does not necessarily follow that a machine that has become obsolete on one operation or job is obsolete on all jobs. There is often a place for such a machine where its service will be effective. The future should bring a more satisfactory plan for the disposition of old, used, and obsolete machine tools.

Notes and Comment on Engineering Topics

The Swedish National Standards Committee has proposed that the Brown & Sharpe tapers, up to and including No. 16, should be adopted as standard for milling machines, and that the Morse tapers, extended according to a plan proposed in Germany, should be used for drilling machines.

The monthly consumption of babbitt metal in the United States amounts to between 5,000,000 and 6,000,000 pounds. Of this, approximately 20 per cent is produced by users for their own needs, while about 80 per cent is sold to users by manufacturers of babbitt metal. These figures are based upon statistics published by the Department of Commerce, Washington, D. C.

An important step in the prevention of explosions in coal mines has been taken by the formulation, through the co-operative effort of all interested groups, of a comprehensive code for rock-dusting coal mines, according to an announcement by the American Engineering Standards Committee. Catastrophes due to coal mine explosions can be prevented by the simple expedient of spreading rock-dust thickly enough to cause an incipient coal dust explosion to die out rather than to travel through the mine atmosphere.

In an address made by Lieutenant J. P. Van Zant at Yale University, it was mentioned that there are under construction in England three giant dirigibles, each twice as large as the *Los Angeles*. These are intended for use in an air service between England and Australia, one service by way of India and another via Canada. It will take two years for the construction of these dirigibles. The British Government was also said to be planning an air route from England to India, by which approximately a week would be cut from the present traveling time to India.

The only successful way in which the railroads can overcome competition with truck and bus lines is to furnish truck and bus service themselves wherever traffic conditions call for such a service. The New York, New Haven and Hartford Railroad has recently formed a $1,000,000 subsidiary company to operate such a service throughout New England. Some of the cars will be run on the highways, but some will be run on the existing railway tracks. This railroad company already has twenty-five gasoline-propelled rail cars in operation.

When the East River Station of the New York Edison Co., now under construction, is completed, it will have a capacity of 700,000 kilowatts, or approximately 1,000,000 horsepower. The new station will cover an area of 207 feet by 1100 feet, and will be twice as great as the largest electrical generating installation now operating under one roof in the central station field, the largest generating station now being one located just outside of Paris. The new station will be capable of producing 100,000 more kilowatts than the projected power development at Muscle Shoals.

Tests made by the Edinburgh Corporation Tramways to determine the economy of pneumatic tires on buses have shown that a fuel saving of approximately 20 per cent has been made by substituting pneumatic tires in place of solid tires. It has also been shown by tests that a bus equipped with pneumatic tires could be brought to a standstill from a speed of 15 miles per hour within a distance of 18 feet, while the same bus with the same brake equipment, but equipped with solid tires, could not be brought to a standstill until it had covered a distance of 34 feet.

In one of the *Research Narratives*, published by the Engineering Foundation, 29 W. 39th St., New York City, reference is made to the life of cast-iron pipes for conveying and distributing water. It is mentioned that cast-iron pipes laid in trenches in the ground in 1665 still supply water to the fountains of Versailles in France. Philadelphia has cast-iron water pipes said to have been in service for more than one hundred years. Recently cement-lined cast-iron pipe has been made with a view to preventing the formation of lumps of rust on the inside of the pipe, which interfere with the flow of water.

A 9000-horsepower General Electric synchronous motor, to be installed by the McKinney Steel Co. at its River Furnace plant, Cleveland, will have what is said to be the highest continuous horsepower rating of any industrial motor in the world. This motor will be direct-connected to a Morgan continuous billet mill, which will probably be in operation early in 1926. This is said to be the first large steel rolling mill in the world to be driven by a synchronous motor. Practically the only other instance of an application of this kind is in the case of some tube rolling and piercing mills in this country which are driven by synchronous motors of approximately 1000 horsepower. The usual practice has been to drive such mills by an induction motor.

About 10 per cent of the total steel output of this country is made up of steel rails for railroad use. During the development of the railroad system of this country, more and more rails were rolled each year, until a peak was reached in 1887, when the production amounted to 2,140,000 tons. In the following years the production of rails decreased, and the record of 1887 was not duplicated until 1899 when 2,273,000 tons were produced. About twenty years ago the railroads began to introduce heavier rolling stock, which necessitated replacing the lighter rails of the past with heavier sections. This again gave an impetus to rail production, so that in 1906 nearly 4,000,000 tons of steel rails were rolled. So far this has been the peak of the annual output of rails in this country. In 1924 the production was 2,433,000 tons.

It is of interest to note that an internal combustion engine constructed by the Niepce brothers in France, in 1806, involved the use of solid combustibles, in powdered form, fed mechanically by a rotary distributor, and the injection of the fuel in the combustion chamber with the aid of compressed air. A writer in *Comptes Rendus* holds that in these two points the inventors of over a century ago anticipated the Diesel patents of 1892 and 1894 covering the same points. The French Technical Aeronautics Service has arranged for the reconstruction of one of the Niepce machines, on which patents were granted in July, 1808. The drawings of this machine are so clear and comprehensive that it has been possible to reproduce the engine with little difficulty. The reconstructed machine has been run, but gave only an efficiency of 4 per cent with the machine cold. The fuel used was powdered coal mixed with resin or lycopodium powder. The Niepce brothers also tried to apply petroleum as a fuel, but failed in this.

PUNCHING PRESSURE

The following approximate rule may be used for rapidly finding the pressure in tons required for punching circular holes in sheet steel: Multiply the diameter of the hole, in inches, by the thickness of the sheet steel, and multiply this product by 90. The result is the pressure, in tons, required. To find the pressure required for punching holes in brass, multiply the diameter of the hole by the thickness, and multiply this product by 75. It will be understood that the foregoing rules give only a rough estimate of the punching pressure, since the latter depends upon the composition of the steel or other material to be punched, and may be varied by shear given to the cutting edges of the punch or die.

PATTERN SHRINKAGE ALLOWANCES

The shrinkage allowances ordinarily made on patterns to compensate for the contraction of castings in cooling are as follows: Cast iron, from 3/32 to 1/8 inch per foot; common brass, 3/16 inch per foot; yellow brass, 7/32 inch per foot; bronze, 5/32 inch per foot; aluminum, from 7/32 to 1/4 inch per foot; steel casting, 3/16 inch per foot. The amount of shrinkage, in any case, depends to some extent upon the shape and size of the casting. A plain casting that is long in proportion to its width will contract differently from one that is more compact, even though both castings have the same weight and were cast from the same material. A heavy iron casting may shrink only 1/10 inch per foot or even less, whereas a lighter casting of the same material may shrink 1/8 inch per foot. A cylindrical or column-shaped casting will contract more in a length-wise direction than radially. Hence, when making patterns for rather large castings of this kind, the allowance should be about 1/10 inch lengthwise and from 1/20 to 1/16 inch per foot radially. For pipes or other hollow castings, the lateral shrinkage is very much less than for solid castings or those having thick walls. A general rule for columns of comparatively small diameter but great length, such as are used for building purposes, is to allow 1/8 inch per foot for shrinkage lengthwise and make no allowance on the diameter. The "one-tenth" shrinkage rule is the standard (for cast iron) in most machine pattern-shops. Although this is not the proper allowance for all forms of casting, the adoption of a standard eliminates the confusion that would follow the use of a number of rules for different classes of work. There can be no fixed rule governing shrinkage allowance, as it is largely a question of local conditions and practice.

UNIFLOW STEAM ENGINES

The uniflow type of steam engine is designed to eliminate one of the greatest losses in reciprocating steam engines, namely, initial condensation. With the uniflow engine, the steam enters the cylinder at the end, after passing through steam-jacketed heads. After expansion has taken place, this steam is exhausted through ports located around the center of the cylinder. The steam flows in but one direction, instead of being returned and exhausting at the end of the cylinder where it enters, as with the ordinary type of reciprocating engine; hence the name "uniflow." It is claimed that initial condensation is almost entirely eliminated in the uniflow engine, where the ends are kept hot and the center or exhaust belt cooler. The uniflow engine was not designed originally for non-condensing service, but a design known as the "universal uniflow" is adapted to either condensing or non-condensing operations, economical results being obtained under both conditions.

GRINDING WHEEL SPEEDS

The peripheral speed of a grinding wheel is usually between 5500 and 6000 feet per minute, but speeds varying from 5000 to 7000 feet per minute are employed. Plain grinding wheels may safely be operated at higher speeds than cup-wheels or those of special shapes; hard wheels may also be run at a higher speed than soft ones. It is the custom of grinding wheel manufacturers to attach a label to each wheel indicating the safe maximum speed for that particular shape and grade of wheel. These recommended speeds should never be exceeded. A committee appointed by representative abrasive wheel manufacturers, in order to determine safe practices in the use of grinding wheels, recommended the following speeds: A peripheral speed of 5000 feet per minute for vitrified and silicate straight wheels, tapered wheels, and shapes other than those known as cup- and cylinder-wheels, which are used on bench, floor, swing-frame, and other machines for rough-grinding. Speeds exceeding 5000 feet may be used upon the recommendation of the wheel manufacturer, but in no case should a speed of 6500 feet per minute be exceeded. A speed of 4500 feet per minute was recommended as the standard operating speed for silicate and vitrified wheels of the cup and cylinder shape, used on bench, floor, swing-frame, and other machines for rough-grinding. For elastic, vulcanite, and wheels having other organic bonds, the recommendations of individual wheel manufacturers should be followed.

SPRING PRESSURES ON PUMP VALVES

For discharge valves, the spring pressure should equal approximately from 0.005 to 0.01 times the water pressure, with a maximum pressure of 5 pounds per square inch. For suction valves, when there is a suction lift, the pressure should equal from 0.25 to 0.5 pound per square inch.

GLYCERINE IN HYDRAULIC MACHINERY

Glycerine has been used extensively in hydraulic presses and similar machinery because it acts to a certain extent as a lubricant, preserves the flexibility of cup leathers, has a high viscosity which makes it less likely to leak through fine pores in castings and defects in joints, and, finally, freezes at a very low temperature. It is also found that in many instances glycerine acts as a protection against corrosion of metallic surfaces. There are, however, other instances where apparently it either induces or accelerates corrosion. From an extensive investigation it would appear that whenever two metals of different electrical potential are employed in hydraulic apparatus with glycerine as the working fluid, the metal that constitutes the negative pole of the electric couple is always the one attacked. The conclusion is that in hydraulic or hydro-pneumatic apparatus employing glycerine as a working fluid, the parts should be so selected that contact of two different metals in the presence of the glycerine is always avoided.

RADIUM

Radium is a metallic chemical element, the symbol of which is Ra, and the atomic weight, 226.4. Radium is a rare metal found only in small quantities and commanding a very high price. It is one of the most remarkable of all metals. It emits light rays which like the X-rays are invisible, but which traverse sheets of glass or metal and cannot be refracted. Radium emits three kinds of rays, which for convenience are called alpha, beta, and gamma rays. Of these, the gamma rays, which greatly resemble the Röntgen or X-rays, have tremendous pentrating power.

TAPER PINS

Taper pins are used as a means for securing two parts of a machine or device to each other; the most common application is for securing collars or hubs to shafts. There is a generally accepted standard for these pins. The taper is 1/4 inch per foot. The pins of different sizes are known by numbers, which indicate the diameters at the large end.

HEAT INSULATING MATERIALS

The best insulating materials for preventing loss of heat in steam or hot water pipes are those that hold air confined in minute cells. Incombustible mineral substances are to be preferred to combustible material. No covering should be less than one inch in thickness. Mineral wool, a fibrous material made from blast furnace slag, is an excellent non-combustible covering, but it is brittle and, therefore, likely to be reduced to a powder when subjected to vibration. The percentage of steam lost through a covering of mineral wool about 1 1/4 inches thick is about one-tenth of that lost from bare pipes. A heat insulation composed of a number of layers of asbestos paper in which are imbedded small pieces of sponge is also very effective. The amount of heat lost with the general commercial pipe coverings is from one-eighth to one-sixth of the amount that would be lost with bare pipes. In most cases, it pays to use the best commercial pipe covering obtainable, because often the material is paid for many times over during the first year by the saving effected by its use. Few steam lines at the present time are provided with a covering thick enough for the greatest net saving. However, where fuel is cheap and the lines are in use only a small percentage of the time, the thinner coverings have their advantages. Also, there are places, as on some heating systems, where the heat lost through the coverings is not wasted. Therefore, a careful study of conditions is necessary before a certain type of covering can be recommended. The durability of materials used for pipe coverings is also an important factor in determining the most economical covering for a given set of conditions. The proper basis for comparing costs is the cost per year and not the first cost of the material.

WALLOON PROCESS

The method of making wrought iron, known as the Walloon process, consists in the melting of long pigs by gradually pushing them forward into a charcoal fire. As the iron melts, it drops and collects in a pasty mass at the bottom of the furnace. In dropping, it passes through a blast of air and becomes partially decarburized and converted into wrought iron. This partially refined iron is then remelted in a charcoal fire, rich slag and hammer scale being added, after which the metal is formed into balls, reheated, and hammered or rolled. This process is used in Sweden for producing wrought iron from Dannemora pig iron.

CHINESE ALLOYS

There are a number of alloys known as Chinese bronze, Chinese copper, etc. These have somewhat varying compositions. Chinese bronze, according to Morin, contains 83 per cent copper, 10 per cent lead, 5 per cent tin, and 2 per cent zinc. Chinese white copper contains about 40 per cent copper, 32 per cent nickel, 25 per cent zinc, and 3 per cent tin. The metal used for Chinese gongs contains 81 per cent copper and 19 per cent tin; this is practically the same composition as that used for bell metal, which is 80 per cent copper and 20 per cent tin.

MINER'S INCH

The term "miner's inch," used in western United States for measuring the flow of a stream of water, is more or less indefinite, because different values have been assigned to it; thus, the amount of water corresponding to a miner's inch varies from 1.36 to 1.73 cubic foot per minute, according to the method used for the measurement. The California Legislature, by an Act of 1901, prescribed that the miner's inch should be equivalent to 1.5 cubic foot of water per minute, measured through any aperture or orifice. The most common measurement is through an aperture 2 inches high and through a plank 1 1/4 inches thick, the width of the aperture being whatever length is required. The lower edge of the aperture is placed 2 inches above the bottom of the measuring box and the plank is 5 inches high above the aperture, so that the head will be 6 inches above the center of the stream through the orifice. Each square inch of the opening represents a miner's inch, and the amount of water that will flow through it equals about 1 1/2 cubic feet per minute..

STUDS AND CAP-SCREWS

Studs are preferable to cap-screws for holding cylinder heads, covers, etc., for the following reasons: (1) A stud and nut can generally be screwed tighter than a capscrew because of better alignment, smoother threads, and reduced effect of torsional elasticity. (2) A stud and nut are less likely to break than a cap-screw, when making repairs. In case a nut is rusted fast on a stud, it can be split with a cold chisel, but a cap-screw "sized" in the casting may be twisted off. This means that the broken part must be drilled out and a new cap-screw provided to take its place. The loss of time and extra labor incident to breakages of cap-screws are important disadvantages when making repairs. (3) Covers secured with nuts and studs can be loosened and tightened without serious deterioration of the fastening means. The nuts on studs can be loosened many times without appreciable wear of the threads, but not so with cap-screws. They soon wear the cast-iron threads and become loose and are likely to strip after being used a few times. (4) Studs have the advantage of holding gaskets in place while a cover is being applied. This is an important advantage in erecting, when the parts are heavy and applied with difficulty. (5) A stud made from a round bar is stronger than a cap-screw turned down from a hexagon bar.

CANTILEVER

A cantilever is a beam which is supported or held firmly at one end and which projects from its support so that the outer end is free and unsupported. Each half of a cantilever bridge, for example, is wholly supported from the abutments and towers at the ends of the span, and the arms that reach out from the towers do not, in any way, depend upon their connection with each other at the center to increase their carrying capacity. They are merely connected, but each arm or cantilever is so proportioned that it is able to carry the load on the bridge independently of the remainder of the structure.

VOLTAGES

The voltage generally used for lighting and industrial power purposes is 125 and 250 volts, and for street railway systems, 500 volts. The demand for still higher voltages for interurban and trunk railways has led to the design of generators for 1200 and 1500 volts, which are operated singly or two in series so as to give an operating voltage of 2400 and 3000 volts.

What Our Readers Think

on Subjects of General Interest in the Mechanical Field

THE PROBLEM OF THE SMALL SHOP

For twenty-one years I have owned a small machine shop in a growing and prosperous city in the Middle West. From my experience, I feel that there is something radically wrong with the machine shop industry, and I believe it is time that everybody connected with it should begin to recognize this, and that the journals in the field should begin to point out the discrepancies between this and other industries.

The plumber who has a box of tools valued at $20 gets $1.45 an hour, and his boss makes $2.25. The carpenter with but a few more tools, gets $1.25 an hour, and his boss makes $1.75 to $1.90. But in the machinery trade, the machinist with tools in his box costing $100 or more, gets 60 cents an hour, and his boss makes, perhaps, $1. This is anything but encouraging to those engaged in the machinery field.

Take up a plumbers' paper and you will find month after month articles against price-cutting. The farmers' papers preach against over-planting and call for higher prices. "A good living and 10 per cent" is the slogan of one farm journal. In the machinery field, we need more cooperation in order to put the small shops, especially, on a living basis. The small shops need an association that will look out for their interests and formulate principles upon which they can carry on their business so as to produce a living for their owners and pay fair wages to skilled men. A. J. M.

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SUGGESTION SYSTEMS IN THE SHOP

Experience with different suggestion systems in various shops has convinced the writer that it is a worthwhile practice to remunerate employes adequately for suggestions that prove to be of value to the firm. Any employe who introduces progressive ideas frequently and consistently is "worth watching." Whenever there is an opportunity, it is well to consider promoting a man of this type to a position of greater responsibility. Unfortunately, some concerns install the suggestion system with the idea of getting as much out of it as they can, and of giving as little as possible in return. This certainly does not tend to improve industrial relations. The suggestion system is unquestionably good, both in theory and in practice, if properly handled, and under favorable conditions it will save the firm money. Like any other system, however, it cannot help but be a failure if it is not correctly planned and properly operated.

During the last eighteen months a suggestion system has been in operation in the shop where the writer is employed. The employes are informed by notices posted in the shop that suggestions on all matters likely to promote more economical operation of the plant will be appreciated, and that a suitable award in cash will be made for suggestions considered of value. An acknowledgement is mailed to the home address of each workman submitting a suggestion.

Requests for suggestions are classed under three headings: Suggestions of any new method—mechanical or clerical—that it is believed will result in greater economy; suggestions for lessening waste of materials; and suggestions for the prevention of accidents.

Although the system referred to has been in operation for only eighteen months, over five hundred suggestions have been received. Some of these have proved useful, and the employes have been awarded various amounts, according to the estimated value of the suggestion. The amount of these awards range from $5 to $50. Approximately 10 per cent of the employes making suggestions have been given awards.

Substantial benefits have undoubtedly been realized through the adoption of the suggestion system. While the plant and equipment were planned and organized by engineers of recognized ability, it has been found that "the man on the job" has been able to suggest changes in many minor details resulting in greater efficiency. Practically no machine tool or machine building plant is so perfectly equipped that good suggestions cannot be offered by the employes if encouragement or rewards are given. In fact, the writer believes that the suggestion system is an effective means of establishing real cooperation, and must be employed if maximum production is to be secured. A. EYLES

* * *

TOOLMAKING IN MANUFACTURING PLANTS

The editorial in June MACHINERY, "The Tool and Contract Specialist," contains much food for thought. Tool designers and toolmakers are employed by all large manufacturing plants for designing and making the tools required in the regular manufacturing routine, and for repairing and maintaining the tooling equipment, but many large plants have found it impracticable to maintain a tool designing department and a tool-room big enough to produce the complete tooling equipments needed when a new or a redesigned product is to be put on a manufacturing basis. In cases of that kind, it has been found more advantageous to call in the tool specialist—the shop that devotes all its time to the designing and building of special tools, gages, jigs, and fixtures.

In so doing, the large manufacturer can take advantage of the specialized experience of men trained in tool design, who year after year devote all their thought to the development of tooling equipment and who, therefore, have become trained in the solving of manufacturing problems in many different industries. The tool shop is in a position to render a service, when temporarily needed, which would be costly for a manufacturing plant, because it could involve the maintenance of a large tool designing and toolmaking force, which during certain periods would be comparatively idle.

A large automobile plant, for example, is primarily concerned with the building, on a production basis, of engines and other parts entering into an automobile. The making of special tools, jigs, and fixtures is not its main purpose. If it turns that work over to a tool shop that specializes on this work, it is likely to gain in two directions—better tools will be obtained at less cost, and the attention of the shop executives of the automobile plant can be concentrated on their main problem, that of manufacturing automobiles, instead of being directed toward the minor details of designing and making tools. V. E.

* * *

The advantages to be gained by manufacturers through the production of "quality guaranteed" merchandise are set forth in a bulletin just issued by the Department of Manufacture of the Chamber of Commerce of the United States, Washington, D. C. The bulletin emphasizes that the buyer will pay for quality, provided the quality is guaranteed, and further calls attention to the fact that trade associations in more than twenty-five different lines have set up standards of quality to protect the buyers of their commodities. This has proved of great benefit to the members of the association, because it inspires the confidence of the buyer.

An Efficient Tool Designing System

By FRANK H. MAYOH

IN order to develop efficient production tools for a part, it is necessary to study the part individually and also in relation to other parts in the complete machine. This study, from an engineering point of view, can be most effectively expressed by means of tool drawings and operation lists. It is a mistake to think that a toolmaker or machinist can make a tool or die that will be satisfactory if he is given only verbal instructions. Tools that have their beginning in such a manner are seldom efficient, and generally will not operate satisfactorily until they have undergone considerable rebuilding.

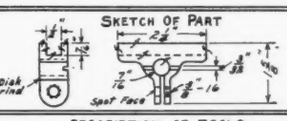
A complete preliminary study of the tools is required, and drawings should be made before attempting to provide the tool equipment for a part. The reason for this is that few men can visualize details that can be readily made clear on a drawing. The accompanying illustrations show how a tooling problem can be handled by the engineering department. When such methods are used, the manufacturing details are more likely to be properly planned and the design of the tools more satisfactory.

In Fig. 3 are shown complete details of a work-holding fixture for milling the part shown in the sketch in the upper right-hand corner of Fig. 1. In the upper right-hand corner of Fig. 3, is a complete list of the materials required to make the fixture, while in the lower right-hand corner is given the title of the fixture, the drawing number, the manufacturer's name, and a space for revision notes.

The sheet shown in Fig. 1 is termed a preliminary operation list, and that shown in Fig. 2 is the final operation list followed in machining the part shown in the sketch in Fig. 1. In the preliminary list, Fig. 1, the part name and number are given at the top. The sketch is made from a detailed drawing of the part for which the special tool equipment is to be made.

DATE 7-4-24 BY F.H.M. DRAWING NO. 418

PRELIMINARY OPERATION LIST

PART NAME AND NUMBER	SKETCH OF PART
Plunger Operating Yoke on 2-C Knitting Machine, part No. 3176-C	

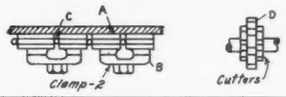
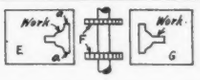
OP. NO.	OPERATION	DESCRIPTION OF TOOLS
1&2	Clean and Disk Grind	
3	Mill 1/2" slot and end, set up gang of 8	
4	Straddle Mill Ends to length 2 - fixtures	
5	Drill, ream and counterbore both holes	Locate from finished surfaces.
6	Mill 3/32" slot	Locate from 7/16" hole and square from end.
7	Mill 1/16" slot	Locate from 1/2" milled slot.
8	Tap and burr	Stock tools.

Fig. 1. Form for Preliminary Machining Plans

Preliminary List of Operations

The tool engineer, after studying the drawing of the part, makes a list of the operations he believes will be required. The list of these operations, in the order in which they are to be performed, is found in the second column from the left, Fig. 1. The first and second operations consist, respectively, of cleaning the casting and disk-grinding the surface indicated in the sketch. The third operation consists of milling a 1/2-inch slot and the faces at each side of the slot. For this operation, a gang type fixture holding eight parts is employed.

After deciding, in a general way, the order and nature of the operations, the tool engineer makes a rough sketch of the tool or fixture required for each operation in the right-hand column of the preliminary operation list. In some instances, however, only the points from which the work is to be located are indicated, particularly when the operation is such that it can be readily performed with standard tools. The sketch provided for the third operation, for instance, indicates that the pieces must be held back against the surface *A* by means of clamps *B*, one clamp serving to hold two parts which are positioned endwise by pins *C*. The arrangement of the gang of milling cutters used for this operation is shown at *D*.

DATE 8/12/24. BY F.H.M. PT. NO. 3176-C DRG. NO. 418.

OPERATION LIST

For Plunger Operating Yoke on 2-C. Knitting Machine.

OP. NO.	OPER. NAME	TOOLS USED	TOOL NO.	USE ON MACH. NO.	MAKE IN DEPT. NO.
1	Clean casting.	Tumbling barrel	---	Std.	23-1
2	Disc grind lower surface.	Disc grinder	----	Std.	23-3
3	Mill 1/2 slot and end.	Milling fixture Gang of 3-cutters Test block	T-17 C-17 213	906	12-1
4	Straddle mill ends.	Milling fixture Gang of 2-cutters	T-18 C-18	811	12-1
5	Drill & ream 7/16 hole, drill, counterbore and spot face for screw.	Drill jig 27/64 drill 7/16 reamer N°-drill 25/64 c'bore 3/4 c'bore	T-19 stock " " " " " " " "	672	8-2
6	Mill 3/32 slot at hole.	Milling fixture 3/32 saw plug gage	T-22 stock 214	Hand Miller	12-3
7	Mill 1/16 slot through boss.	Milling fixture	T-23	811	12-1
8	Tap screw hole.	Holding bar 3/8-16 tap	T-24	Tapping Mch.	8-3
9.	Burr.	Hand operation	---	Bench	17-2

MATERIAL USED; Brass castings from pattern No. 418

Fig. 2. Final Operation List

Fixture Sketches

For the fourth operation, two fixtures are mounted on the milling machine table in the positions indicated in Fig. 1. The work clamped in the fixture shown at *E* is fed against the cutters *F*, which finish the ends *a* of the work. Another piece of work is placed in the fixture shown at *G* while the ends *a* of the first piece are being milled. The work in fixture *G* is then fed to the cutters while that in fixture *E* is removed and replaced by a new piece. The remaining opera-

tions require no special tools or fixtures, and only brief notes in the column headed "Description of Tools" are given.

The preliminary operation list is used as a general guide in designing the tool equipment. It is not necessary that the preliminary list be strictly adhered to, and often some point comes up in working out the design of a fixture that makes it advisable to change or modify the original plan. After the tools and fixtures have been designed, the heads of the production and engineering departments should talk over the plans outlined and the general design of the tools. Any changes that may then be decided upon can be easily made in the drawings. After the design of the tools and the methods of performing the various operations are settled, the final operation list shown in Fig. 2 is made out. This list shows the order in which the operations are to be performed, and is used in calculating the cost.

It will be noted that there are nine operations on the final list, whereas only eight appear on the preliminary list. It will also be observed that the final list has columns for the operation number, name of operation, names of the tools used, and the tool numbers. The tools are called for at the tool-crib by their respective numbers, and the machines on which they are to be used are indicated by the numbers or notations in the fifth column. The sixth column shows in which department the operation is to be performed. The kind of material from which the part is to be made is specified in the space at the bottom of the list.

Detail Drawings of Fixtures

The complete details for the fixture used in the third operation listed in Figs. 1 and 2, are shown in Fig. 3. The completely assembled fixture is shown by the plan and elevation views in the upper left-hand corner, while below these views are details of parts used in the fixture. The position of the work in the fixture is indicated by the heavy dot-and-dash lines. Each part in the assembled views is designated by a numeral enclosed with a circle, and each part shown by a detailed view is similarly designated.

A complete list of the materials required in constructing the fixture is given in the upper right-hand corner of the drawing. The symbol number of each part is found in the column headed "Sym." The number of parts of each kind required is given in the next column to the right, and the specifications for the material required, in the adjacent column. The list of materials enables the stock clerk to get the necessary materials together. When the fixture is in use, the operator places the two parts shown at the right-hand end of the elevation view in position and starts the feed, following which he clamps the next two pieces in place.

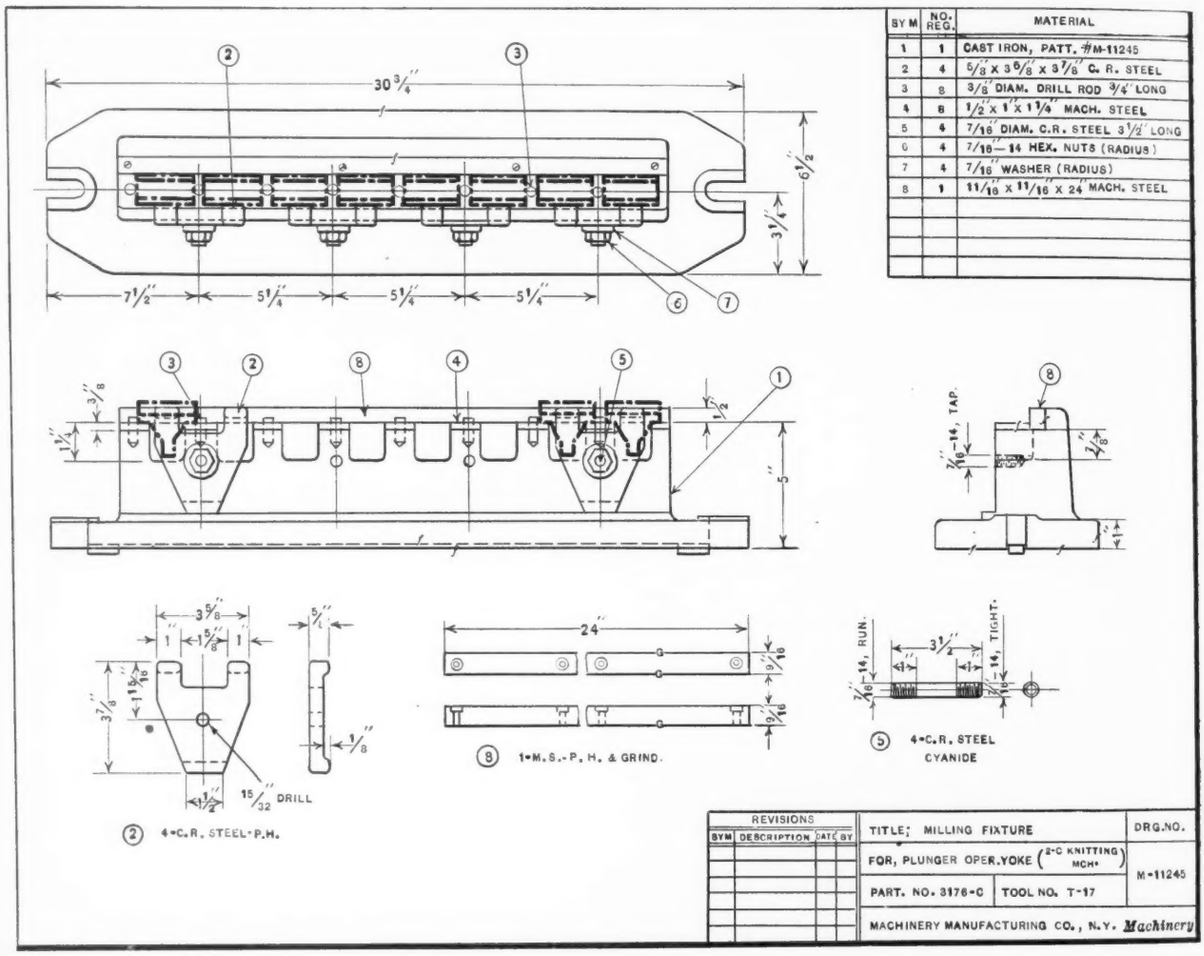

SYM | NO. REQ. | MATERIAL
1 | 1 | CAST IRON, PATT. #M-11245
2 | 4 | 5/8" x 3 5/8" x 3 7/8" C. R. STEEL
3 | 8 | 3/8" DIAM. DRILL ROD 3/4" LONG
4 | 8 | 1/2" x 1" x 1 1/4" MACH. STEEL
5 | 4 | 7/16" DIAM. C.R. STEEL 3 1/2" LONG
6 | 4 | 7/16"—14 HEX. NUTS (RADIUS)
7 | 4 | 7/16" WASHER (RADIUS)
8 | 1 | 11/16 x 11/16 x 24" MACH. STEEL
30 3/4"
7 1/2"
5 1/4"
6 1/2"
3 1/4"
5"
24"
3 1/2"
15/32" DRILL
2 4-C.R. STEEL-P.H.
8 1-M.S.-P. H. & GRIND.
5 4-C.R. STEEL CYANIDE
REVISIONS
SYM | DESCRIPTION | DATE | BY
TITLE; MILLING FIXTURE
DRG.NO.
FOR, PLUNGER OPER. YOKE (2-C KNITTING MCH.)
M-11245
PART. NO. 3178-C
TOOL NO. T-17
MACHINERY MANUFACTURING CO., N.Y. Machinery

Fig. 3. Details of Special Fixture for milling Part shown in Upper Right-hand Corner of Fig. 1

* * *

EDUCATIONAL VALUE OF EXHIBITS

About twenty leading American colleges and universities will send their students of chemistry and chemical engineering to the Tenth Exposition of Chemical Industries at the Grand Central Palace, New York, during the week September 28 to October 3. A special course has been arranged in connection with this exhibit for students of chemistry, which is in charge of Professor W. T. Read of the Chemistry Department of Yale University. A program of lectures has been prepared, and some of the leading authorities on engineering methods, materials, and equipment, will be among the speakers. The lectures will be held during the morning hours, at the Grand Central Palace, prior to the official opening of the exposition each day, and tours among the exhibits for practical demonstrations will then be made. The course is given without cost to the students.

HEAT-TREATMENT FOR CARBON AND ALLOY SPRING STEEL

The following practice for the heat-treatment of plain carbon and alloy spring steel has been recommended by the Recommended Practice Committee of the American Society for Steel Treating (4600 Prospect Ave., Cleveland, Ohio). This practice covers the process to be followed in the manufacture and heat-treatment of medium and large coil springs and flat leaf springs.

Kinds of Steels Used

Spring Steels are manufactured largely by the open-hearth process. A considerable quantity of this class of steel is also produced by the electric furnace, and a small amount by the crucible process. The chemical composition of the carbon and alloy spring steels most commonly used by spring manufacturers is given in Table 1.

Hardness of Spring Steels

In Table 2 are given the Brinell hardness numbers recommended for various spring steels. The maximum hardness limit of leaf spring steel should depend to a considerable extent upon the nature of any cold work to be performed upon it. A maximum Brinell hardness number of 321 is satisfactory for springs that are less than 5/16 inch in thickness, where only the simple cold-working operations such as shearing, punching, and trimming are necessary. Heavier springs (over 5/16 inch in thickness) should have a maximum Brinell hardness number of 302. A maximum hardness limit is necessary only in special cases.

All coil spring bars 1/2 inch and under should be soft enough to permit shearing without breaking. Larger bars should be purchased cut to the required lengths.

Forging, Forming, and Coiling

In forging, forming, and coiling spring steel, the lowest temperature at which the steel will work satisfactorily should be used. This temperature should not exceed 1850 degrees F., and the steel should be held at this temperature for only sufficient time to allow it to soak through thoroughly. The method of cooling after forging or forming is usually not important. When severe coiling or other severe forming operations are performed, the steel should be allowed to cool in the air until it becomes black.

Heat-treatment of Spring Steel

Normalizing.—The steel is normalized when considerable machining is required, when severe cold-working is to be done, or when the product has been subjected to localized heating at several places for the purpose of forging. The normalizing temperatures are given in Table 2.

Hardening.—The steel should be heated uniformly to the temperature given in Table 2, and quenched in oil. The time, in minutes, of heating in the furnace may be determined approximately by multiplying the diameter or thickness of the steel, in inches, by 60.

Tempering.—The steel should be heated in a suitable tempering medium to the temperature given in Table 2. It should be held at this temperature for a sufficient time to permit complete penetration of the heat. The method of cooling after tempering is optional.

Hardness Testing of Finished Product

The Brinell test is widely used on flat leaf springs, and when specified should conform to the limits given in Table 2. Hardness tests on helical springs may be made by the Brinell, Rockwell, or scleroscope tests. When the Brinell test is specified, it should conform to the limits given in the table.

* * *

Up to 1918 the increase in railway freight traffic in this country, as measured in revenue ton-miles, was at the rate of about 7 or 8 per cent a year, the traffic doubling in from twelve to fourteen years. Since 1918 there has not been this proportionate increase in freight traffic. In 1923, the largest revenue ton-mile year in the history of American railroads, the traffic, instead of having doubled since, say, 1910, had increased only 65 per cent; and in 1924, the traffic was 6 per cent less than in 1923. It is quite evident that the remarkable increase in railway freight traffic that characterized the development of new territory in the United States cannot be expected to continue at the same ratio as in the past, but, slowly, a more static condition is being reached, where comparatively small increases in business and in railroad traffic can be expected from year to year.

TABLE 1. APPROXIMATE CHEMICAL COMPOSITION OF CARBON AND ALLOY SPRING STEEL

Kind of Steel	Per Cent Carbon		Per Cent Manganese		Per Cent Phosphorus	Per Cent Sulphur	Per Cent Silicon		Per Cent Chromium		Per Cent Vanadium		Per Cent Molybdenum	
	Min.	Max.	Min.	Max.			Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Carbon	0.90	1.05	0.30	0.50	0.040	0.050	0.10	0.25	....	....	....	....	....	....
Chromium	0.45	0.55	0.80	1.00	0.040	0.050	0.10	0.20	1.00	1.20	....	....	....	....
Chromium-Vanadium	0.45	0.55	0.70	0.90	0.040	0.050	0.10	0.20	1.00	1.20	0.15	0.25	....	....
Chromium-Molybdenum	0.45	0.55	0.70	0.90	0.040	0.050	0.10	0.20	0.70	0.90	....	....	0.20	0.30
Chromium-Silicon-Manganese	0.45	0.55	0.70	0.90	0.040	0.050	0.40	0.60	0.70	0.90	....	....	....	....
Silicon-Manganese	0.55	0.65	0.70	0.90	0.045	0.050	1.80	2.10	....	....	....	....	....	....

Machinery

TABLE 2. DATA FOR HEAT-TREATING LEAF AND COIL SPRINGS

Kind of Steel	Normalizing Temperature, Degrees F.		Hardening Temperature, Degrees F.		Approximate Tempering Temperature,* Degrees F.		Brinell Hardness Number	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Carbon	1575	1625	1525	....	600	950	352	415
Chromium	1600	1650	1525	....	650	950	363	444
Chromium-Vanadium	1600	1675	1550	1600	675	975	363	444
Chromium-Molybdenum	1600	1675	1550	1600	675	975	363	444
Chromium-Silicon-Manganese	1600	1650	1600	1650	675	975	363	444
Silicon-Manganese	1600	1650	1600	1650	650	950	363	444

Machinery

*Temperatures given are to be used only as guide in obtaining the Brinell hardness numbers given in this table.

Production Methods in a Tractor Plant

Second of Two Articles Describing Some of the More Unusual Operations Performed at the Tractor Works of the International Harvester Company, Chicago, Ill.

VARIOUS operations performed in building tractors at one of the Chicago plants of the International Harvester Co. were described in August MACHINERY. Other operations in the same plant, selected either because of some unusual feature or to illustrate the quantity production methods employed, will be dealt with in the present article. Fig. 2 shows how the main frame casting is milled on top for its entire length. This is a difficult part to handle because of the shape and weight, but the particularly interesting feature of the operation is that the machine is arranged with four roughing cutters on each side of the main frame and two finishing cutters at the middle, making a total of ten cutters. With this set-up, two castings, held in jigs at each end of the table, can be rough- and finish-milled complete while two other castings are being loaded into jigs at the opposite end of the table. The two roughing cutters that operate on any one casting interlock, but the finishing cutter is large enough in diameter to extend across the entire top of the work.

From the milling machine, the main frame castings are loaded, one at a time, into the jig shown in Fig. 5, which runs on a track and is indexed in order to perform two drilling and one tapping operation. These operations require two machines. The jig is also swiveled 180 degrees from the position shown, to facilitate reloading. In the operation illustrated, two longitudinal settings of the jig are necessary because of the length of the work, the drills not used in either step clearing all surfaces.

Milling the Ends of Front Axles and Broaching Flywheels

The ends of front axles are milled three at a time by employing six cutters, as illustrated in Fig. 3. An indexing fixture is employed so that when one end of the axles is milled, it is a simple matter to bring the opposite end to the cutters. The latter are about 14 inches in diameter, and of the inserted-blade type. A block *A* is provided near each end of the axles, against which they are held for sidewise location by spring-actuated pins attached to blocks *B*, which push against the axles at the middle. These blocks can be conveniently withdrawn for reloading. Endwise location of the axles and clamping are accomplished by means of heavy clamps *C*, which are tightened on both ends. These clamps are each provided with a tongue that enters a groove on the face of the fixture.

Two keyways are broached simultaneously on opposite sides of the bore of the flywheels, as illustrated in Fig. 4. These keyways are 1/2 inch wide, have rounded bottoms, and are broached to a depth of 17/32 inch. The work is seated on an arbor that is slotted to guide the broaches as

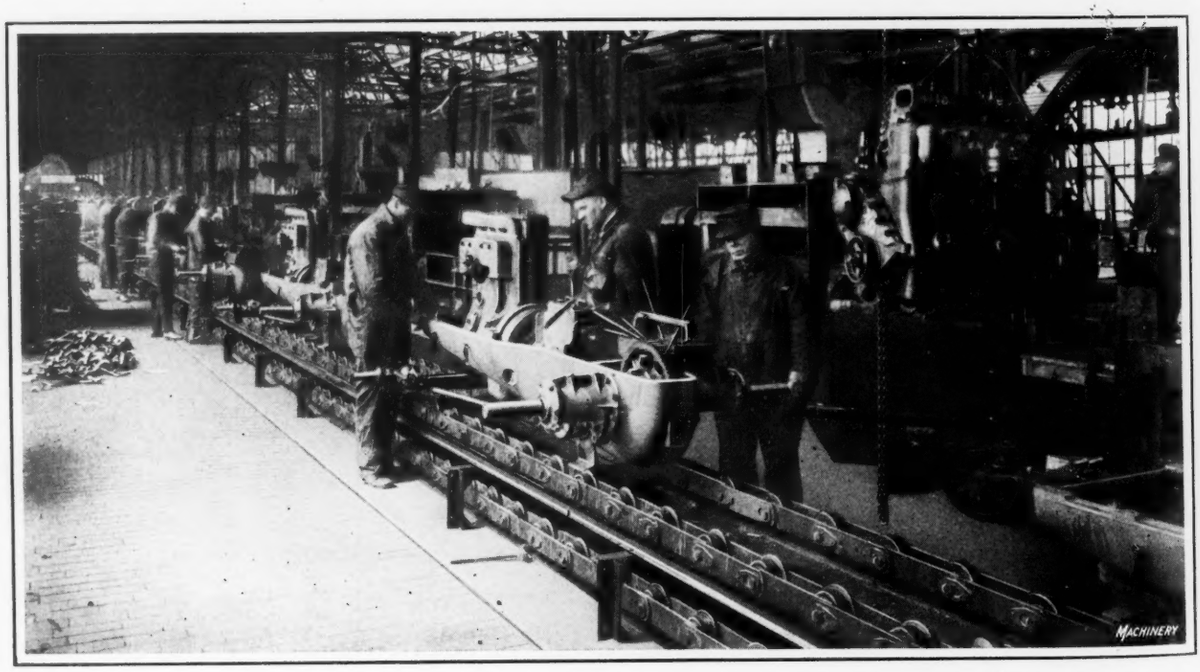


Fig. 1. General View of the Assembly Line along which the Various Units and Parts are assembled into Complete Tractors that are driven away from the End of the Line under their Own Power

they are pulled through the work. A length of about 4 feet is used on each broach for removing the metal, and the broaching speed is about 47 inches per minute. The flywheels are iron castings.

Drill Jig of Economical Design

Seventeen holes are drilled in the bottom of one motor front cover at the same time that four holes are drilled in the top of another, by employing the set-up illustrated in Fig. 6. It will be seen that the machine is equipped with a four-station box jig which is indexed on horizontal trunnions. This arrangement permits reloading as each side of the jig is indexed into the front vertical position. The piece of work on the right-hand side of each face of the jig is located by means of pilot *A* and two pins that engage the edge of the large hole near the opposite end of the work. Then nut *B* is tightened to bring the star clamp beneath it against a rib of the work and four equalized fingers firmly against the outside of the casting. Equalizing clamps *C* and *D* are finally tightened by turning the thumbscrews.

The piece of work on the left-hand side of the jig is located by means of studs that enter two of the holes drilled when the work was on the right-hand side, and the part is locked in position by means of swinging clamp *E*. In the actual drilling, pilot *A* serves to guide the bushing plate when the drill head of the machine is lowered, and pilot *F* functions similarly for the left-hand piece. The operator simply depresses a treadle to withdraw a lock-pin whenever it is desired to index the jig, which is revolved by hand.

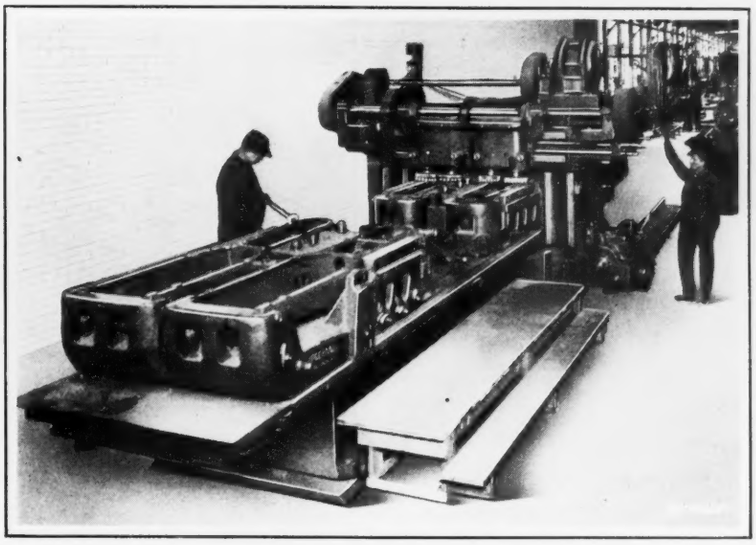


Fig. 2. Milling the Main Frame in a Machine equipped with Eight Roughing Cutters and Two Finishing Cutters

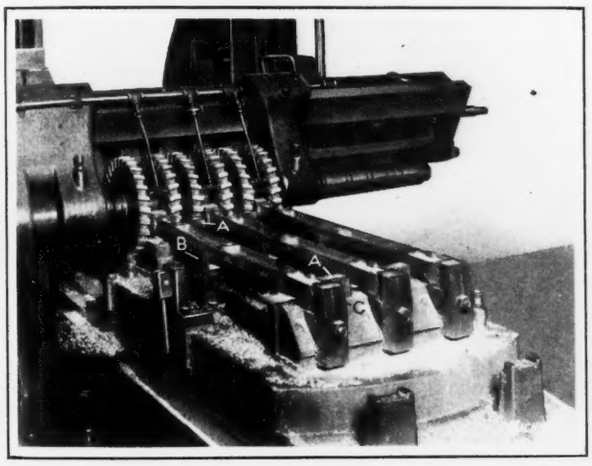


Fig. 3. Milling Three Front Axles simultaneously on Both Ends

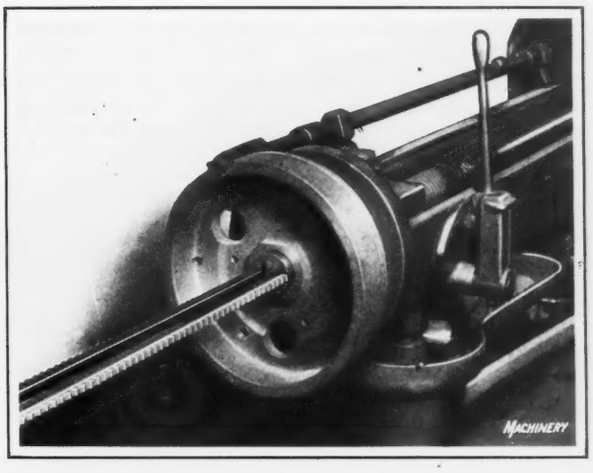


Fig. 4. Broaching Two Keyways in the Bore of a Flywheel

Nut Castellating Fixture

Two hundred and fifty nuts are castellated per hour, on an average, by means of the set-up shown in Fig. 7, and during this time the operator also files all the burrs from the six slots produced. The machine is a rotary miller built by the Craftsman Tool Co., Conneaut, Ohio, and is equipped with a large drum for carrying the nuts past the 4-inch cutters. At the ends the drum is provided with jaw disks *A* and *B* which are slotted to receive the corners of the nuts and to hold the flat sides in line with the cutters, the latter being mounted on an arbor extending across the top of the machine. Vees are also provided on each end of the drum proper.

The jaw disks are mounted on the same shaft as the drum, and they are split on each side of the vees for a distance of about 5 inches from the edge, so as to give spring to the jaws. As the jaw sections rotate slowly up the front of the machine, they are sufficiently

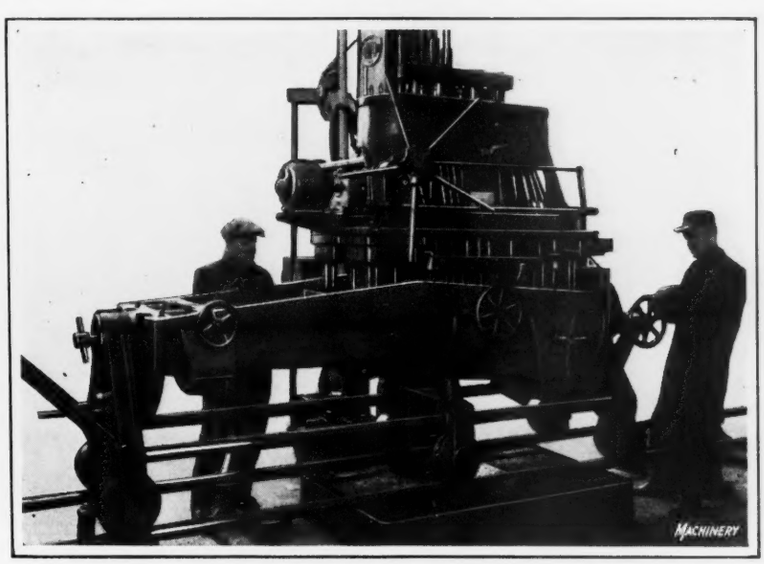


Fig. 5. Drilling Thirty-eight Holes in the Main Frame with Two Settings of the Jig

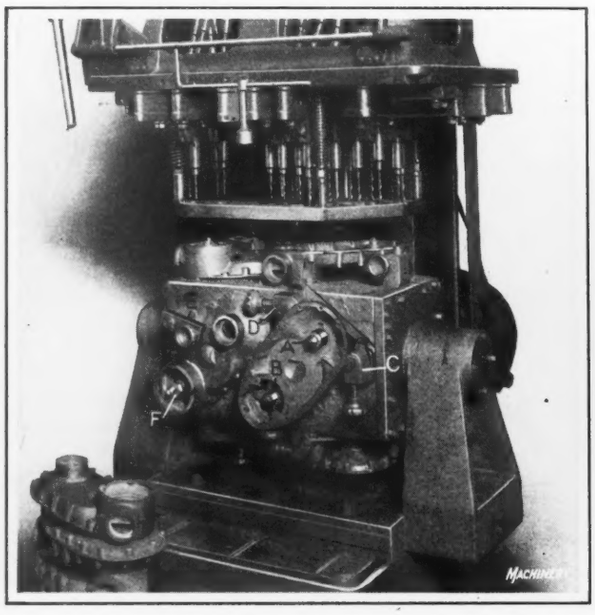


Fig. 6. Trunnion Jig used in drilling Motor Front Covers, Twenty-one Holes being Drilled at One Time

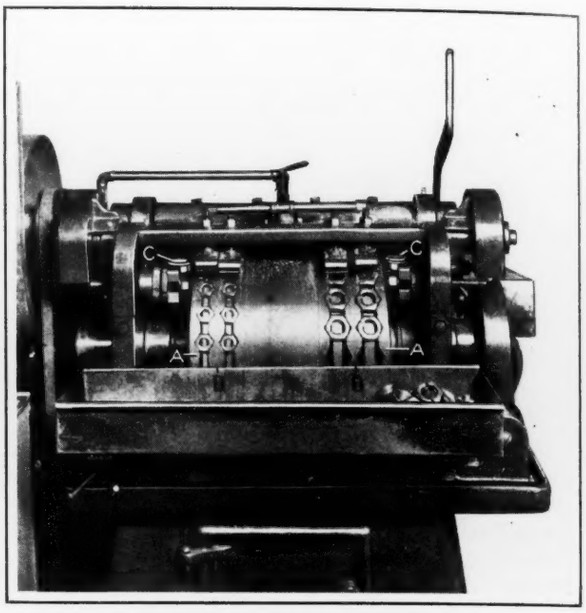


Fig. 7. Continuous Milling Machine employed for castellating Nuts in Large Quantities

spread to permit the ready insertion of the nuts, but as they carry the nuts to the cutters, a roller *C* bears against each jaw disk *A*, forcing it and the jaws of disk *B* toward the drum, so as to hold the nuts firmly for the operation. Each nut is presented to the cutters three times in different positions for cutting all the slots. The production averages 150 small nuts and 100 large nuts per hour.

Punching and Rolling the Tires

Rear tires for the tractors are produced from flat plates of steel 11 feet long, 12 inches wide, and 1/4 inch thick. One hundred and ninety-two holes are punched in these plates at one time by means of the large punching machine illustrated in Fig. 8. Of these holes, 160 are 11/16 inch in diameter, and the remainder 13/32 inch. Simultaneously with the punching, the plates are sheared to length by knife blades at each end. For the operation, the plate is first thrown on the brackets in front of the punches and then pushed beneath the stripper plate against stops. Blocks are raised in front of the forward edge of the plate by lifting a handle so as to prevent the plate from shifting. It will be seen that the punches are staggered as to height, so that not all of them reach the work at the same moment.

After the punching operation, the steel plate is rolled into a circle, and the ends are welded together. Then the tire is brought to the machine illustrated in Fig. 9 to have each edge turned up about 1 1/4 inches. For this operation the tire is supported on the large revolving roller *A*, and it is bent to shape as the upper revolving roller *B* is slowly lowered on it. The pressure exerted in bending causes the work to rotate with the rollers. In its rotation it is guided by two revolving members *C*, which are conical shaped on the sides in contact with the tire, so that they continue to guide the tire as it decreases in width. Pulley *D* revolves against the tire to prevent it from swinging during the operation.

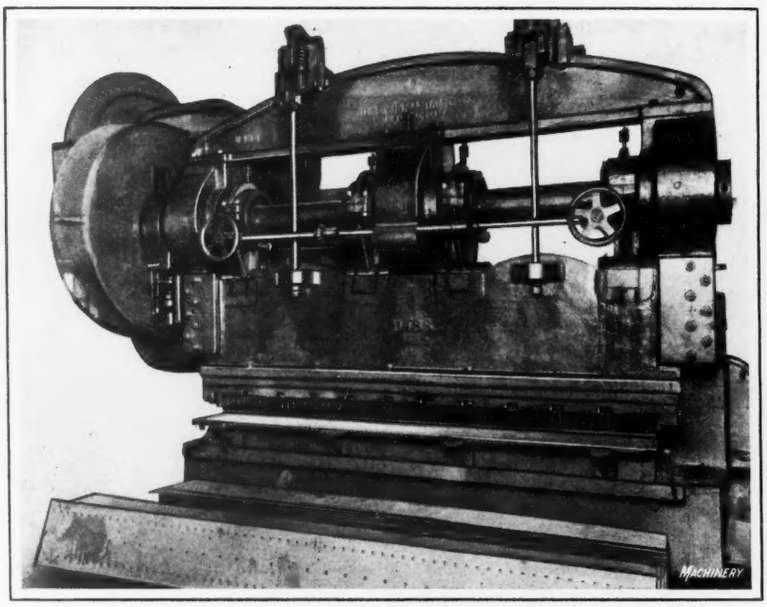


Fig. 8. Heavy Punching Machine by Means of which 192 Holes are punched in Steel Plates for Tires

Method Used in Assembling

The assembly of the tractors is performed by methods similar to those used in automobile plants, as may be seen from Fig. 1, which shows a view of the assembly line near the beginning. The engines are first assembled on a separate track, and then delivered to a department where they are subjected to dynamometer and other tests for two hours. At the end of these tests, the crankcase is removed to permit final examination of the connecting-rod bearings, and then it is reassembled. The engines are delivered directly from the test room to the assembly line to be placed in the main frame, which is the operation being performed in the foreground of Fig. 1.

When the various parts, with the exception of the wheels, have been assembled, the tractors reach the booth shown in Fig. 10, where paint is sprayed over them by means of air brushes. Any parts that are to maintain their natural color are first covered to prevent the paint from adhering to them. Running along the top of this booth is a big suction box into which the excess paint is drawn through large openings near the bottom of the booth on each side and through passages that lead up the sides and over the roof to the suction box, from which it is finally exhausted into the air. There

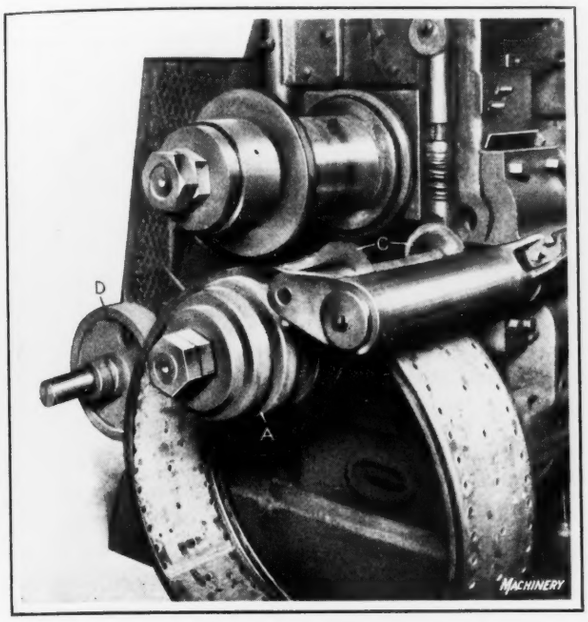


Fig. 9. Rolling up Flanges of the Tires for the Rear Wheels of the Tractors

are several pockets in the roof of the booth where electric lamps are installed for lighting up the work.

After the tractors leave the paint booth, the wheels are assembled; and the tractors pass through a drying oven, after which gasoline, oil, and water are supplied, the engines are started, and finally, at the end of the line, the tractors are driven off under their own power, as shown in the heading illustration.

* * *

AIRPLANE CONTEST FOR FORD TROPHY

A trophy has been presented by Edsel Ford, to be competed for in a national airplane tour to start September 28 and last for about six days. A route of about 1900 miles will be covered, with over-night stops, as now planned, at Chicago, Omaha, Kansas City, St. Louis and Columbus. The start will be made from Ford Airport, Dearborn, Mich., and during the week of the tour many developments in airplane construction and equipment that will be of great interest to the public, as well as to the industry, will be shown at an exposition of aeronautical appliances to be held at Ford Airport. The purpose of the tour and exhibition is to demonstrate the reliability of flying machines and to familiarize the public more generally with commercial aviation.

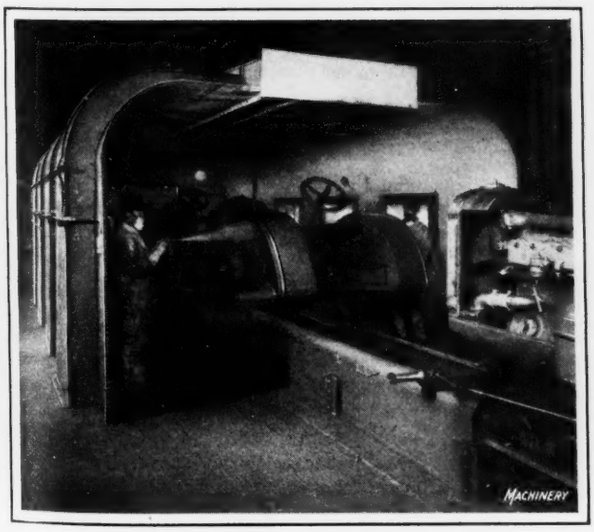


Fig. 10. Booth erected over the Assembly Line in which the Tractor is painted by Air Brushes

RAILROAD SHOP PRACTICE MEETING

Plans are now completed for the regional meeting of the American Society of Mechanical Engineers to be held in Altoona, Pa., October 5, 6, and 7. At this meeting the technical program will deal with railroad shop practice and transportation problems. Altoona, as is well known, is the home of the largest railroad shops of the Pennsylvania Railroad.

Altoona was not "on the map" until 1850, when this point in the Appalachian Mountains became the base of operations for the construction of a difficult section of the Pennsylvania Railroad. At that time, a number of small shops were erected in the then nameless village. At the suggestion of a Danish engineer, the new railroad town was named after Altona, a city then belonging to Denmark where the first railroad shop in Denmark was built. The extra letter "o" was added, however, to establish the individuality of the American town.

Today, Altoona is the mechanical shop center of the Pennsylvania Railroad, and over 15,000 men are employed there in the production and maintenance of locomotives, passenger and freight cars, and a great variety of miscellaneous railroad equipment. Of especial interest to every mechanical engineer is the testing plant at Altoona. The locomotive test table there erected permits the operation of a locomotive at all speeds up to eighty miles an hour and is provided with all the instruments and apparatus necessary to measure and record every item in the performance of the engine.

In connection with the regional meeting, the council of the American Society of Mechanical Engineers will hold its regular meeting at Altoona, October 5. It is of interest to note that the third meeting of the American Society of Mechanical Engineers was held in Altoona in April, 1881, and was attended by thirty-seven members. At that time, a visit to the Pennsylvania Railroad shops was also a feature of the meeting.

* * *

THE DAWES PLAN AND IMPORTS FROM GERMANY

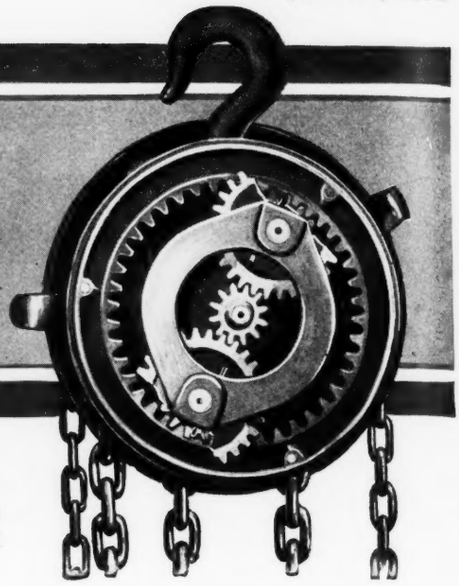
At the recent convention of the Foreign Trade Council at Seattle, Wash., and at the meeting of the International Chamber of Commerce at Brussels, Belgium, both held during the same week, the Dawes plan and its effect on imports were thoroughly discussed. Sir Josiah Stamp, a British economist, said in part: "I intend to give the convention a straight talk which is likely to prove unpalatable, that the Dawes' plan is endangered and the time has come when the Allies must choose whether they want reparations or to further paralyze Germany. They must recognize that Germany cannot meet reparations payments in cash, but only by goods from her export surplus. French, Italians, and others must renounce their hopes of getting gold from Germany while they are excluding German goods. This applies further if Europe pays her debts to America, who must accept Europe's goods. Deflecting these goods to other markets does not solve the problem, because such outlets are scant and would result in competition with America's exports."

He cast doubts on the wisdom of the United States policy of receiving gold payments, and predicted the breakdown of the Dawes' plan within three years unless these six conditions were met: (1) Creditors must not press Germany for payments quicker than trade policy allows. (2) Tariff walls must be razed. (3) Restrictions based on similarity of manufactures must be abandoned. (4) Tariffs designed to equalize cost must be abrogated. (5) Creditors must not seek to restrict Germany's policies of labor and work hours. (6) Objections of industrial organizations to the flow of German goods must pass unheeded.

Nevertheless, the adoption of the Dawes' plan was a great step forward, because it places squarely before the industrial nations the issues involved in the payment of huge indemnities and national debts. These cannot be paid in gold, for no nation has a sufficient amount of gold to do that. They must be paid by goods manufactured or by raw materials, or not paid at all.

Planetary Gearing

By FRANKLIN DeRONDE FURMAN
Professor of Mechanism and Machine Design
at Stevens Institute of Technology



Secondary Drives for Increasing Range of Speed Ratios—Compound Planetary Trains—Form of Planetary Mechanism for Very Large Speed Reductions—Concluding Installment

IN the present article, which is the concluding installment of the series on planetary gearing, the use of a supplementary drive in conjunction with the main driving member, in order to extend greatly the possible range of speed ratios obtainable with the planetary form of gearing, is to be considered first; then a planetary train consisting of spur and bevel gears, in combination, will be presented, to be followed by compound planetary trains, and, finally, a form of planetary mechanism capable of very large speed reductions.

Bevel Type of Planetary Gearing with Supplementary Drive for Varying Speed Ratio

A variable drive of the bevel planet type is shown in Fig. 76. Shaft G drives shaft H through the bevel sun wheels D and D_1 and the bevel planet wheel D_3. The latter is carried on a radial pivot in the spur sun wheel D_2, which is independently driven by the pinion K.

Case 1—If the pinion K is held stationary, D_2 will be stationary, and the entire device will act as a simple transmission, all wheels having fixed centers. If the angular velocity of the drive shaft G is AB, in a clockwise direction, the angular velocity of the follower shaft H will be equal to it, as shown at CF, but in an opposite direction. By the graphical solution,

$$N' = \frac{+AB}{-CF} = \frac{+5}{-5} = -1$$

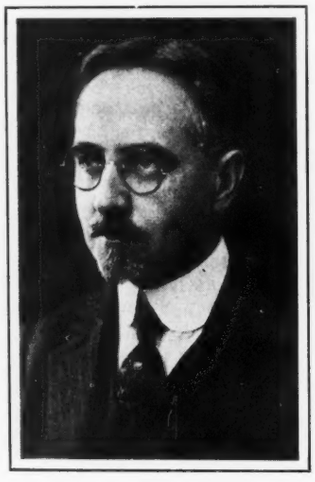
the values AB and CF being measured to any convenient scale. Here, again, as in the previous bevel gear problems, lines used in the graphical solution actually lie in a plane perpendicular to the paper, but are shown in the illustration as if they were revolved 90 degrees into the plane of the paper, to save the drawing of a top view. The analytical solution for this case is written the same as for a simple train of gears, as follows:

$$N' = -\frac{D}{D_3} \times \frac{D_3}{D_1} = -\frac{90}{36} \times \frac{36}{90} = -1$$

it being assumed that there are 90 teeth in the sun wheels D and D_1 and 36 teeth in the planet wheel D_3. (For notation, see end of article.)

Case 2—It will now be assumed that a tangential motion PE is given to the supplementary drive wheel K, the main drive shaft G and wheel D continuing at the same speed A_1B_1 as before. The tangential linear velocity PE of K is transferred to P_1E_3 and reduced to A_1J_1 in order that the speeds of the wheels D and D_2 may be compared on the same terms. Then the speed of D_2 is to the speed of D as A_1J_1 is to A_1B_1, or measured to scale, as 1 to 3. By laying off the original velocity value of D at AB, and the supplementary velocity value A_1J_1 at NJ_4, which represent the linear velocities of points A and N, respectively, on the planet wheel D_3, the instantaneous axis of the wheel is found to be at N_1, and the velocity at point C on D_3 is found to be CF_1. Since AB and CF_1 are the same distance from their respective shaft centers G and H, they represent the final angular velocities of these shafts and

$$N' = \frac{-CF_1}{+AB} = \frac{-1.66}{+5} = -\frac{1}{3}$$



FRANKLIN DERONDE FURMAN, author of the series of articles on "Planetary Gearing" that has appeared in MACHINERY during the last year, and of which this is the last, has, since 1893, been instructor, assistant professor, and professor of mechanism and machine design at Stevens Institute of Technology, Hoboken, N. J. Professor Furman was born in Ridgely, Md., in 1870, and graduated from Stevens Institute of Technology in 1893. He is a member of the American Society of Mechanical Engineers and of the Society for the Promotion of Engineering Education. Among the numerous books of which he is the author are: "Valves and Valve Gears for Steam Engines and Steam Turbines"; "Questions and Problems in Machine Design"; "Valves and Valve Gears for Gas, Gasoline, and Oil Engines"; "Questions in Engineering Drawing"; and "Cams, Elementary and Advanced."

The analytical solution may be written in the usual form of $N' = 1 +$ etc., but it becomes more cumbersome than necessary, so it will be shortened by simply writing the terms of an abbreviated analysis as follows:

$$N' = -\frac{D}{D_3} \times \frac{D_3}{D_1} + 2 \times \frac{1}{3} \times \frac{D}{D_3} \times \frac{D_3}{D_1}$$

$$= -1 + \frac{2}{3} \times 1 = -\frac{1}{3}$$

Hence the follower shaft H turns at one-third the speed of shaft G, and in the opposite direction, when wheel D_2 is driving with one-third of the speed of D, and in the same direction. The term $-\frac{D}{D_3} \times \frac{D_3}{D}$ in this formula represents the velocity and direction given to D_1 while D turns once; and the term $+ 2 \times \frac{1}{3} \times \frac{D}{D_3} \times \frac{D_3}{D_1}$ the additional velocity and direction given to D_1 while D stands still and D_2 turns through one-third of a revolution according to the conditions of the problem.

Case 3—The next case to be considered consists in giving a velocity to K that will cause D_2 to turn at one-half the speed of D and in the same direction. In this case the points A and N on the planet wheel will have linear velocities of AB and NJ_5, respectively, and C will be the instantaneous axis of the planet wheel. Since this axis falls at C on wheel D_1, the latter wheel will not be driven, but will remain sta-

tionary. Then by the graphical solution, $N' = \frac{0}{AB} = 0$, and by the analytical solution

$$N' = -\frac{D}{D_3} \times \frac{D_3}{D_1} + 2 \times \frac{1}{2} \times \frac{D}{D_3} \times \frac{D_3}{D_1} = -1 + 1 = 0$$

Case 4—Assume that wheel K is given such a velocity that D_2 has two-thirds the velocity of D. In this case, according to the graphical solution,

$$N' = \frac{+CF_3}{+AB} = +\frac{1.66}{5.00} = +\frac{1}{3}$$

The analytical solution is written:

$$N' = -\frac{D}{D_3} \times \frac{D_3}{D_1} + 2 \times \frac{2}{3} \times \frac{D}{D_3} \times \frac{D_3}{D_1}$$

$$= -1 + \frac{4}{3} \times 1 = +\frac{1}{3}$$

Auxiliary Drive Applied to Special Form of Bevel Planetary Gearing

A differential bevel planetary gear that will permit of exceedingly fine variations of speed between the driving and follower shafts, which are in line, is shown in Fig. 77. The drive shaft G has keyed to it the sun wheel D, which has 100 teeth. The planet bevel wheels D_3 (with 20 teeth), and D_4 (with 30 teeth) are keyed to one shaft S, which turns freely in sleeve T; sleeve T is integral with the hub R and the spur tooth wheel D_2, which is driven by an outside independent governing wheel K. The hub R turns freely on the projecting ends of the shafts G and H, the latter being the follower shaft and having keyed to it the bevel follower wheel D_1 (with 80 teeth). To make a definite problem of this mechanism, let it be assumed that the wheel K is turning fast enough to give D_2 one-quarter the speed of D. What will be the speed and direction of turning of the shaft H with relation to D?

In the graphical solution, let AB represent the angular velocity of shaft G and wheel D. Then AB_1, equal to AB, represents the linear velocity of point A on bevel wheel D_3. But bevel wheel D_3 has an angular velocity about G equal to one-fourth that of D about G. To translate this to a definite linear velocity on D_3, draw A_1B_2 equal to AB, at the same elevation as A, and make A_1B_3 equal to one-fourth A_1B_2. Then locate J_1 directly over A_1, and draw J_1Q until it meets a radial line drawn through M and B_3. The distance J_1Q then represents the velocity of the center point J on the planet wheel D_3, due to rotation about G, and is laid off at JQ_1. With the resultant velocities AB and JQ_1 of D_3 known, its instantaneous center is found at C. Since D_3 and D_4 are integral through the shaft S, C_1, projected down, becomes the instantaneous center of D_4, and EF the linear velocity of D_4 at E, found by drawing through C_1 a line parallel to CQ_1B_3. Then EF_1, equal to EF, represents the linear velocity of point E or the follower wheel D_1 and of the follower shaft. Therefore,

$$N' = \frac{EF_1}{EH} \div \frac{AB}{AG}$$

$$= \frac{6}{8} \times \frac{10}{8} = \frac{15}{16}$$

Analytically, the formula for the solution is written:

$$N' = \frac{D}{D_3} \times \frac{D_4}{D_1} - 2 \times \frac{1}{4} \times \frac{D}{D_3} \times \frac{D_4}{D_1}$$

$$= \frac{100}{20} \times \frac{30}{80} - \frac{1}{2} \times \frac{100}{20} \times \frac{30}{80} = \frac{15}{16}$$

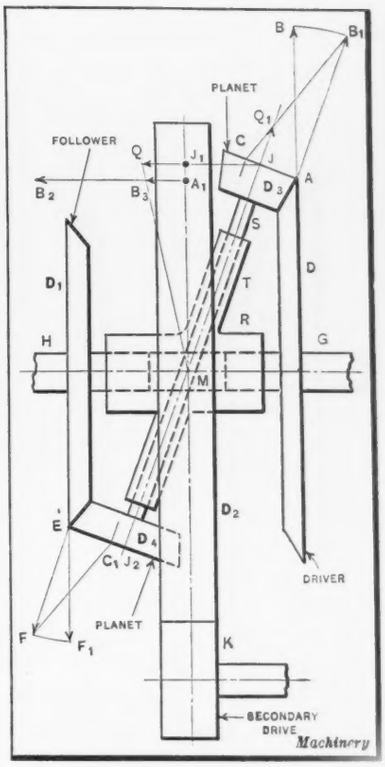


Fig. 77. Another Form of Bevel Planetary Gearing with Secondary Drive

Planetary Mechanism Formed of Spur and Bevel Gears

A combination of spur and bevel gears forming a planetary train is shown in Fig. 78. The fixed spur wheel D_2 is fastened to the base W. The spur planet wheel D_3 is carried on a pin G which turns freely in the driving train arm T. The bevel planet wheel D_4 is keyed to pin G, thus making D_3 and D_4 integral. The bevel planet wheel D_5 is attached to the pin H, which turns freely in the upright bearing on the train arm. Pin H carries an index-finger which is the follower member of the mechanism and has the same motion as D_5.

The graphical solution for this problem is accomplished by assigning the linear velocity AB to the handle A on the train arm. This causes the center of the spindle G and the centers of the wheels D_3 and D_4 to move with a velocity GH. Since the point C on D_3 is momentarily at rest, the angle GC_1H represents the angular velocity of all points on the planet wheel mass D_3GD_4, and PE is the linear velocity of the point Q of this mass. The velocity of Q on the bevel wheel D_5 must also be PE, because D_5 is in pure rolling contact with D_4. But the velocity of the center point H of D_5 is PF, due to rotation of the train arm about M; therefore the velocity of Q on D_5, relative to the center point H, is $PF—PE$, and the angular velocity of D_5 on its own center is $\frac{PF—PE}{HQ}$. The angular velocity of the driver train arm is $\frac{AB}{AM}$; consequently,

$$N' = -\frac{PF—PE}{HQ} \div \frac{AB}{AM} = -\frac{2.8}{3} \times \frac{5.5}{5} = -1 \text{ approx-}$$

imately, or, expressed in words, the index-finger, or follower, makes one turn in one direction while the train arm makes one turn in the opposite direction. The minus sign in this expression is due to the fact that if the driving train arm T is assumed to turn backward from the paper, the points Q on wheels D_4 and D_5 will also be turning in the same direc-

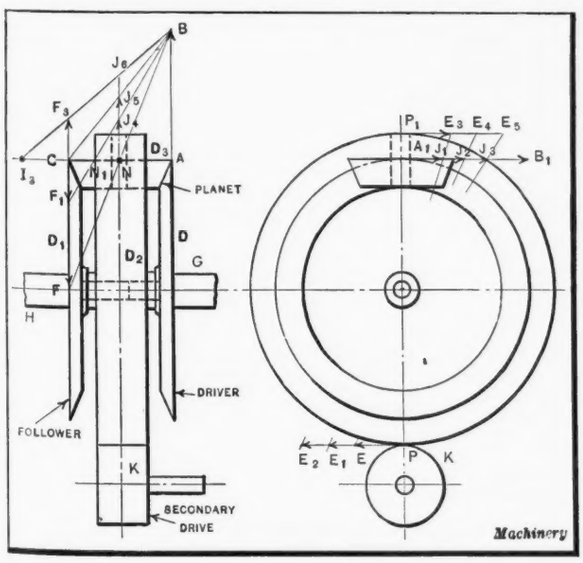


Fig. 76. Planetary Gearing of Bevel Type provided with Secondary Drive for extending Range of Speed Ratios

tion, and the top of D_5 will be coming forward from the paper. The follower is, therefore, carried forward from the paper while the train arm T moves backward.

The analytical formula is:

$$N' = 0 - \frac{D_2}{D_3} \times \frac{D_4}{D_5} =$$

$$0 - \frac{40}{40} \times \frac{15}{15} = -1$$

The zero in this formula, it will be recalled from the study of bevel planet wheels illustrated in Fig. 25, Article 6, is due to the fact that when the entire mechanism was given its initial turn about M, the 90-degree planet bevel wheel D_5 and the follower did not turn on their own axes. The minus sign in the formula is obtained when the fixed wheel is turned back, as it then ultimately turns the follower in the opposite direction to that in which the entire mechanism was originally turned.

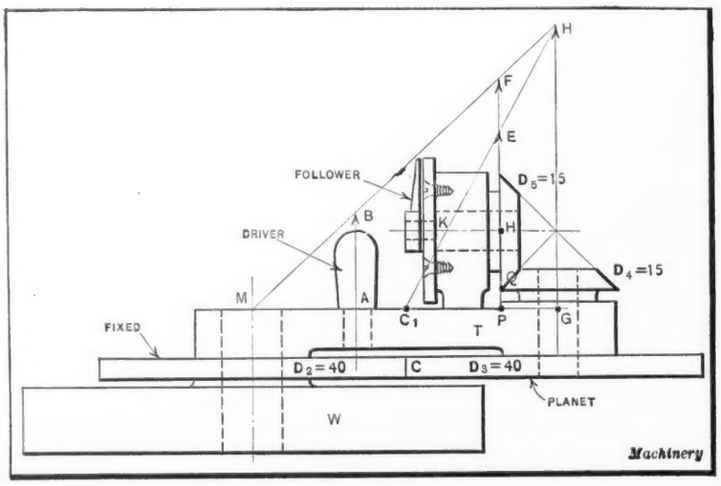


Fig. 78. Planetary Train in which Spur and Bevel Gearing are combined

The mechanism shown in Fig. 78 may be used to construct a mechanical paradox, similar to Ferguson's mechanical paradox illustrated in Fig. 44, Article 9. All that would be necessary to accomplish this in the present case, would be to place three spur wheels on the pin K in place of the index-finger, using a central wheel having, say, 30 teeth, an outside wheel with 29 teeth, and an inside one with 31 teeth. Then the vertical bearing on the train arm T would be built up so as to carry another pin similar to K on which three more spur wheels would be placed, the center one having 30 teeth and gearing with the 30-tooth wheel directly below it; the outside wheel would have 31 teeth and would gear with the 29-tooth wheel directly below it, etc. Then if the six spur wheels had the same outside diameter, the slight differences in the pitch circles and the numbers of teeth on each set of wheels would not be noticed; they would all appear to be exactly the same to the casual observer, and one would expect, therefore, that they would all have the same motion. Yet when the train arm was turned, it would be found that the front or outer top spur wheel would lag slightly behind the middle wheel, and the back or inside top spur wheel would gain slightly on the central wheel. The relative motions would be: Outer wheel $\frac{29}{31}$ and inner wheel $\frac{31}{29}$ that of the central wheel.

A compound train arm with spur gears composing one train and bevel gears the other train is illustrated in Fig. 79. The first train arm T turns on a pin in the base W, and carries the idler planet spur wheel D_3 and the intermediate follower wheel D_4. The spur wheel D_2 is rigidly attached to base W. The spur wheel D_4 and the second train arm T_1 are rigidly attached to the pin U, which turns freely in T. The bevel spur wheel D_5 is rigidly attached to T. Train arm T_1 carries the idler bevel wheel D_6 and the final follower wheel D_7, attached to the pin V which rotates freely in T_1. It is required to find the number of turns and the direction of turning of D_7 for one turn of the train arm T. The wheels are all of the same pitch, and the sizes are represented by the numbers of teeth as follows: $D_2 = 48$; $D_3 = 12$; $D_4 = 48$; $D_5 = 30$; $D_6 = 12$; and $D_7 = 30$.

The graphical solution is involved, but is, perhaps, more certain and dependable than the analytical method. Both methods will be given. In the graphical method, let AB represent the velocity of the driving train arm handle. Since D_2 is fixed, RF will be the velocity of the tangent points on the pitch circles D_3 and D_4. The velocity of the center of wheel D_4 will be PE, and from the geometry based on the relative sizes of the wheels, $PE = RF$. Therefore, wheel D_4 has simple translation and no rotation about its own center. Since the second train arm T_1 is rigidly connected to D_4, the point P_1 at the end of the pin that carries D_6 will also have a motion perpendicular to the paper equal to PE, as indicated at P_1E_1.

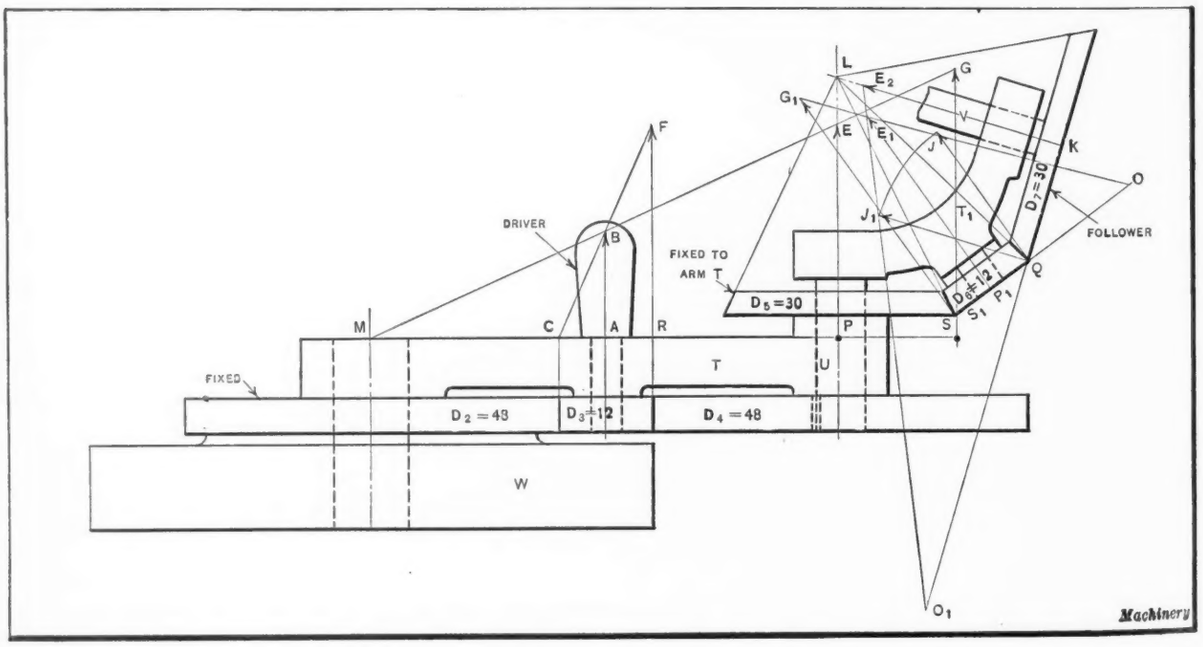


Fig. 79. Compound Planetary Train consisting of Two Train Arms with Spur and Bevel Gears

The point S_1 on D_6, however, has the same motion as S_1 on D_5, and D_5 is revolving about M with a velocity SG, it being remembered that wheel D_5 is rigidly fastened to the train arm T. Therefore S_1G_1 is laid off equal to SG. The two motions P_1E_1 and S_1G_1 of D_6 are now known, and they determine the instantaneous axis O of D_6, by the aid of which the velocity QJ of the tangent point of the pitch circles of D_6 and D_7 is determined. The point K on the center line of the pin V must have the same velocity as the several points in the train arm T_1, and this is $KE_2 = PE = P_1E_1$. With KE_2 and $QJ_1 = QJ$ known, the instantaneous axis O_1 of the wheel D_7 is found. Since the rotation of a wheel about its instantaneous center is the same as the rotation of the wheel with respect to its own center, $\frac{KE_2}{KO_1}$ represents the rate of turning of D_7. The rate of turning of the driving train arm T is $\frac{AB}{AM}$. Therefore,

$$N' = \frac{KE_2}{KO_1} \div \frac{AB}{AM}$$

Measuring these values to any convenient scale,

$$N' = \frac{9}{20} \times \frac{10}{4.5} = +1$$

The follower bevel wheel D_7 makes one turn on its own center while the train arm T rotates once about its axis at M.

The analytical solution for the problem represented by Fig. 79 is accomplished by first finding the value (N'') for the wheel D_4, to which the secondary train arm T_1 is rigidly attached. This part of the solution is identical with that for the problems illustrated in Articles 4 and 9, Figs. 15 and 43, respectively; in this case (Fig. 79),

$$N'' = 1 - \frac{D_2}{D_3} \times \frac{D_3}{D_4} = 1 - \frac{48}{12} \times \frac{12}{48} = 0$$

Hence, the wheel D_4 does not turn at all on its own axis when the train arm T is turned once, or any number of times. Stated differently, it means that the wheel D_4 has a motion only of circular translation, in which any diametral line, or other line, drawn on the face of the wheel D_4 remains parallel to its original position while the center of the wheel D_4 moves in the path of a circle that has MP for its radius. Since D_4 does not turn on its axis, the train arm T_1, which is rigidly attached to D_4, does not turn, but always remains parallel to its present position. The wheel D_5, however, revolves about the axis at M, which is equivalent to its rotating once on its own center so far as its engagement with D_6 is concerned, it being remembered that the train arm T_1 remains always parallel to its present position; therefore the remaining part of the problem, as far as the analytical solution is concerned, resolves itself into a train of gears with fixed centers, the wheel D_5 being the driver, and the value N''' for D_5 is as follows:

$$N''' = \frac{D_5}{D_6} \times \frac{D_6}{D_7} = \frac{30}{12} \times \frac{12}{30} = 1$$

With $N'' = 0$, and $N''' = 1$, it follows that $N' = 1$. Since the minus sign did not predominate in the equation for N'', and since D_7 turned the same way as D_5 in the equation for N''' it follows that the final wheel D_7 makes one turn while the train arm T makes one turn, both in the same direction.

Simultaneous Rotation of Driven Member about Two Perpendicular Axes

Simultaneous rotation of an object about two perpendicular axes may be obtained with a compound planetary mechanism such as is shown in Fig. 80. The driving crank AM turns a spindle which has keyed to it the spur sun wheel D and the bevel sun wheel D'. The spur wheel D drives the planet spur wheel D_3, mounted on a pin attached to the train arm T, which rotates freely on the shaft XM. The sun wheel D_2 is a large internal gear wheel rigidly fixed to the frame of the machine. The train arm T carries two bevel planet wheels D_4 and D_5 on free-turning pins, the former wheel being simply a transmission idler, and the latter the final follower gear of the entire train. The latter gear wheel has an arm Y fixed at its center, and reaching to W. For one turn of the driving crank AM, the sphere at W will make three turns about the vertical axis YY and one-third turn about the horizontal axis XX for the proportions shown in Fig. 80. The sizes of the gear wheels, as represented by the numbers of teeth (all wheels being of the same pitch), are: $D = 30$; $D' = 60$; $D_2 = 60$ (internal); $D_3 = 15$; $D_4 = 15$; and $D_5 = 15$.

The graphical solution for the planetary mechanism just described is indicated in Fig. 80, where AB represents the linear driving velocity of the handle A. The velocity of the

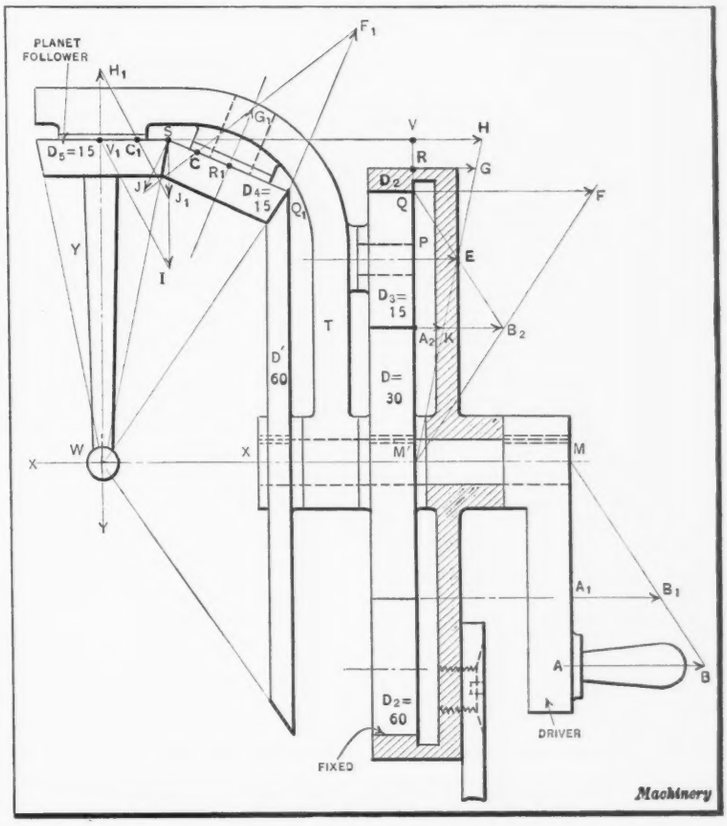


Fig. 80. Planetary Mechanism which provides for Simultaneous Rotation of Sphere at W about Two Perpendicular Axes

pitch circle of wheel D will be A_1B_1, and this transferred to A_2, which is a driving point between wheels D and D_3, will be A_2B_2. Since the point Q on wheel D_3 is at rest, the center of D_3 will have a velocity PE which represents the velocity of the train arm T. Therefore, the number of turns of the train arm T to one of the driver crank AM is as follows:

$$N' = \frac{PE}{PM'} \div \frac{AB}{AM} = \frac{2}{9} \times \frac{9}{6} = \frac{1}{3}$$

or, taking $M'A_2$ as the unit radius, the result is read directly as:

$$N' = \frac{A_2K}{A_2B_2} = \frac{1}{3} \text{ approximately}$$

Since the point P on the train arm T has a motion PE, the point R_1 on the train arm, and on the planet wheel D_4, will have the linear velocity RG, which is laid off at R_1G_1. The planet wheel D_4 is also driven at the point Q_1 by the bevel sun wheel D' which has a velocity QF at Q_1; this velocity is laid off at Q_1F_1. With the two velocities R_1G_1 and Q_1F_1 of the wheel D_4 known, its instantaneous center is found at C, and the point S, which drives the wheel D_5, has a linear velocity SJ. The latter velocity, when laid off at

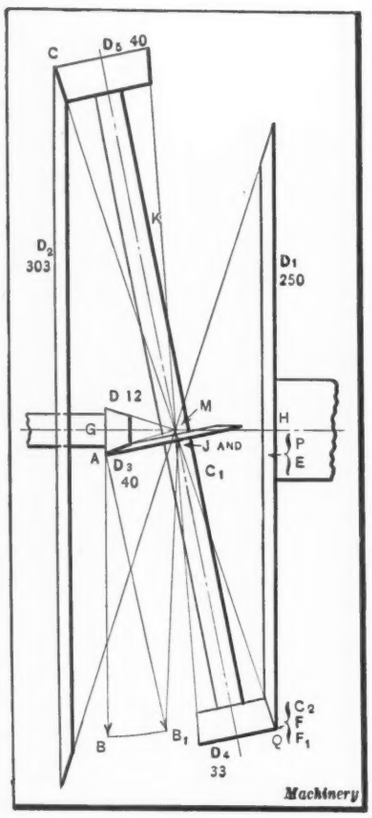


Fig. 81. Planetary Gear Combination having a Speed Reduction of 262,500 to 1

SJ_1, represents the velocity at S of the wheel D_5. The point V_1 on D_5 is also a point on the train arm, and therefore has a linear velocity VH which is laid off at V_1H_1. With the two velocities SJ_1 and V_1H_1 of D_5 known, its instantaneous center C_1 is found. Then the angle $V_1C_1H_1$ represents the angular velocity of the physical center V_1 of D_5 about its instantaneous center C_1; or, to put it in another way, the angle SV_1I, which equals $V_1C_1H_1$, represents the angular velocity of the instantaneous center C_1 and of all other points on D_5 relative to the center point V_1 of D_5. Therefore the measure of the angular velocity of D_5 with reference to its own center is $\frac{SI}{SV_1}$ and

$$N'' = \frac{SI}{SV_1} \div \frac{AB}{AM} = \frac{6}{3} \times \frac{9}{6} = 3$$

or the planet bevel wheel D_5 and the arm Y make three turns while the drive crank makes one turn. The relative direction of turning of the crank AM and the wheel D_5 and spindle Y is such that if the point A on the drive crank is coming forward from the paper, the point S on D_5 will also be coming forward, while the points A_2, P, Q_1, R_1, and V_1 that have been under discussion will be moving backward from the paper.

The analytical solution for the planetary mechanism illustrated in Fig. 80 is extremely simple, but it calls for close consideration. The number of turns of the drive crank AM to one of the train arm, is as follows:

$$N = 1 + \frac{D_2}{D_3} \times \frac{D_3}{D} = 1 + \frac{60}{15} \times \frac{15}{30} = 3$$

or the turns of the train arm to one of the crank equals $N' = \frac{1}{3}$ as found in a preceding paragraph. The analytical formula for the remainder of the problem is perhaps most easily written by making use of the information already found; namely, that the wheel D' is turning three times as fast as the train arm T. Then when the entire mechanism is revolved once as one solid piece, as assumed in the analytical method, the wheel D' will have two more turns to make in the same direction while the train arm T stands still, and therefore the formula will be written:

$$N''' = 1 + 2 \times \frac{D'}{D_4} \times \frac{D_4}{D_5} = 1 + 2 \times \frac{60}{15} \times \frac{15}{15} = 9$$

or the wheel D_5 and spindle Y will turn nine times on their own axis while the train arm T turns once, both in the same direction. Since the train arm has already been found to make one-third turn while the drive crank AM makes one turn, it follows that the wheel D_5 and spindle Y will make three turns on the axis YY while the drive crank AM makes one turn. Since the axis YY of the spindle may be considered as an elementary line of the train arm, it follows that the sphere W, which is at the end of the spindle, turns about the axis XX with one-third the angular velocity of the drive crank AM.

Speed Reduction of 262,500 to 1

A planetary gear mechanism giving a reduction in speed of 262,500 to 1 is illustrated in Fig. 81. The particular mechanism here illustrated was originally devised by Dr. Charles W. MacCord, former professor of mechanical drawing at Stevens Institute of Technology, Dr. MacCord was the first, to the writer's knowledge, not only to devise a planetary bevel mechanism with such a large finite ratio of reduction, but also to introduce (previous to 1878) the particular arrangement using opposite pairs of bevel wheels in planetary gearing for other than balancing purposes. As large as this reduction is, it is not comparable with the infinite reduction represented by the gearing illustrated in Fig. 13 of Article 3, where the reduction was as infinity to one. When reductions as large as the present one are encountered, it is obvious that the scale of the drawing of the velocity diagram would have to be far beyond the limits of drafting-room practice in order to apply directly the graphical method of solution, for, in the present problem, the initial line representing the driving velocity would have to be 262,500 times the length of the final line representing the follower velocity. Although the reduction in the present problem is large, the values involved are finite and must be recognized throughout the solution, whereas in the problem where the reduction is infinity to one, it readily develops in a convincing manner that the troublesome lines that are too short to be represented on any practical scale are really of zero length, and therefore may be represented with accuracy and certainty even on a small-scale drawing, as in Fig. 13.

Inasmuch as uncertainty is likely to develop in the application of the analytical method to new and complex problems, it becomes of some importance to develop a way of employing the graphical method to serve as a check on the analytical. Where spur wheels only are employed in the mechanism, this matter does not have so much weight, for the drawing not only of the object lines, but of the velocity lines as well, may be made to convenient exaggerated scales, and the geometrical method readily used. (The geometrical method was described and illustrated in the early articles in this series). Where bevel wheels are used, the geometrical method may also be used, but the necessary computations are more complex and tedious than the analogous method

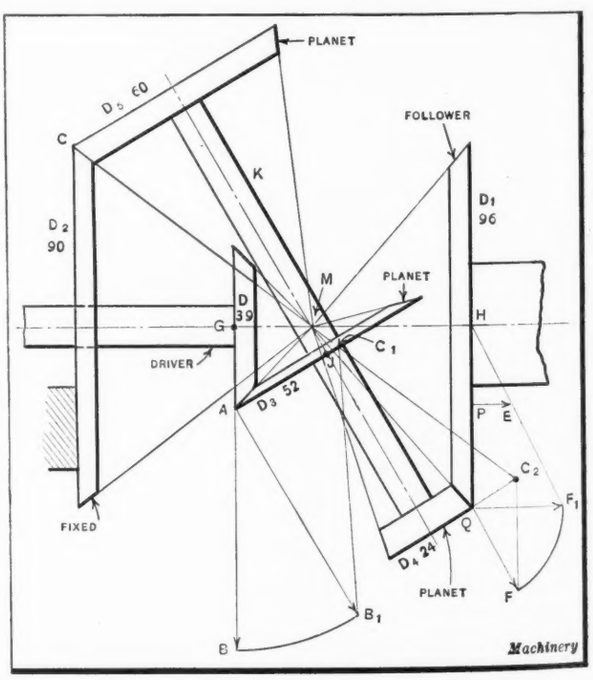


Fig. 82. Mechanism of Type shown in Fig. 81, but of Different Proportions, to illustrate Application of Graphical Solution

that will be employed in this problem and described in the following paragraph. A brief description of the mechanism illustrated in Fig. 81 is as follows: The shaft G drives the intermediate shaft K which has rigidly fixed to it the bevel planet wheels D_3, D_4, and D_5. Shaft K is constrained to move so that its center line always passes through the point M. The planet wheel D_5 rolls on the fixed wheel D_2, and the planet wheel D_4 drives the follower wheel D_1 and the shaft H. The numbers of teeth in the several wheels are as follows: $D = 12$; $D_1 = 250$; $D_2 = 303$; $D_3 = 40$; $D_4 = 33$; and $D_5 = 40$.

For reasons set forth in the preceding paragraph, a similar mechanism will be laid out in Fig. 82, in which the reduction in speed is low enough to enable one to draw all the necessary velocity lines with sufficient precision to obtain an approximately correct answer by the graphical method, and thus check the analytical method. In Fig. 82, the parts are lettered the same as in Fig. 81, and the description of the mechanical construction, as given in the preceding paragraph, applies also to Fig. 82. In Fig. 82 the numbers of teeth in the wheels are as follows: $D = 39$; $D_1 = 96$; $D_2 = 90$; $D_3 = 52$; $D_4 = 24$; and $D_5 = 60$.

The graphical method of solution is applied by assigning the velocity AB to the driving wheel D at the point of tangency A of the pitch cones of the bevel wheels D and D_3. Then AB_1, perpendicular to AJ and equal to AB, will represent the velocity of point A on D_3. It should be recalled that D_3 is a member of the rigid body composed of D_4, D_5, and shaft K, and that the line CMC_2, being an element of the pitch cone of D_5, is theoretically a part of this rigid body. But the line CMC_2 must be momentarily at rest, because it represents the line of engagement of the toothed wheels D_4 and D_2, and D_2 is a wheel rigidly fixed to the frame of the machine. Therefore the point C_1 on the line CC_2 becomes the instantaneous center about which the point A on the wheel D_3 is turning, and the angle AC_1B_1 represents the angular velocity of the point A on the wheel D_3. Just as C_1 on the line CMC_2 was the instantaneous center of the wheel D_3, so the point C_2 is the instantaneous center of the wheel D_4; and further, the point Q on D_4 must have the same angular velocity about the instantaneous axis as point A, because Q and A are points on the same rigid body. Therefore the angle QC_2F is drawn equal to AC_1B_1; then QF becomes the resultant linear velocity of point Q on D_4, and QF_1 represents the resultant linear velocity of point Q on the follower wheel D_1. If the linear velocity QF_1 is reduced to PE at radius HP, equal to the radius AG at which the driving velocity was assigned to wheel D, then the angular velocities of the two shafts G and H may be read directly as $N = AB \div PE$, which, measured to a convenient scale, gives $N = 12 \div 2.1 = 5\ 5/7$, approximately.

By the analytical method of solution, the number of turns of shaft G and wheel D, after the entire mechanism is rotated once around the sun wheel axis and the fixed wheel then revolved back, is:

$$N_1 = 1 + \frac{D_2}{D_5} \times \frac{D_3}{D} = 1 + \frac{90}{60} \times \frac{52}{39} = 3$$

And the number of turns of the follower wheel D_1 and shaft H under the same considerations is:

$$N_2 = 1 - \frac{D_2}{D_5} \times \frac{D_4}{D_1} = 1 - \frac{90}{60} \times \frac{24}{96} = \frac{5}{8}$$

Then the number of turns of shaft G to one turn of shaft H is

$$N = \frac{N_1}{N_2} = 3 \times \frac{8}{5} = 4\ 4/5$$

Applying the graphical method of solution to the problem illustrated in Fig. 81, in which the reduction is 262,500 to 1, it is found that the pitch cones of the wheels D_4 and D_5 are almost identical, and that the point C_2 on the extended element of the pitch cone of D_5 is so close to the point Q of the element of the pitch cone of D_4 that the distance cannot be shown graphically to any convenient scale. Therefore it becomes impractical to lay off at QC_2 (as in Fig. 82) a similar triangle to AC_1B_1, which represents the angular velocity of the rigid body (composed of the wheels D_4,D_5,D_5, and shaft K) about the line CMC_2, which is the instantaneous axis of this body. If it is attempted to lay off such a similar triangle at QC_2 to scale, it will be found that the points Q, C_2, F and F_1, which correspond to similar points in Fig. 82, all fall at the point Q, and that the final line QF_1 appears to be of zero length, instead of the very small finite length which it really is. It follows that the line that really exists at PE in Fig. 81, and that is analogous to the line PE in Fig. 82, also appears to be of zero length and cannot be measured. Hence, the values in the expression $N = AB \div PE$ cannot be measured practically, and the answer cannot be found even approximately by this method.

The analytical method of solution, however, may be readily applied with as much certainty as it was in Fig. 82, where it was checked against the graphical method. In Fig. 81, then, the number of revolutions of the drive shaft G and shaft H, after the entire mechanism has been revolved once about the sun wheel axis and the fixed wheel D_2 turned back, will be

$$N_1 = 1 + \frac{D_2}{D_5} \times \frac{D_3}{D} = 1 + \frac{303}{40} \times \frac{40}{12} = 26.25$$

And the number of turns of the follower wheel D_1 and shaft H will be:

$$N_2 = 1 - \frac{D_2}{D_5} \times \frac{D_4}{D_1} = 1 - \frac{303}{40} \times \frac{33}{250}$$

$$= 1 - \frac{9999}{10000} = 0.0001$$

Then the number of turns of shaft G to one turn of shaft H will be:

$$N = \frac{N_1}{N_2} = \frac{26.25}{0.0001} = 262{,}500$$

A conclusion that may be drawn from the analytical solution just given, as well as from the analytical solutions that have been applied to several problems in this series, where large reductions in speed have been obtained, is that it is essential in planning such a mechanism to find a combination of sun and planet wheels which, when combined in their proper order, will give a product for the numerator which is less, by one, than the product for the denominator. This is illustrated in the formula $N_2 = 1 - \frac{303}{40} \times \frac{33}{250}$ in the preceding paragraph, where the product of the numbers in the numerator is 9999, and the product for the denominator is 10,000. Another conclusion that may be drawn is that when the numerator is less, by one, than the denominator, the value of the expression will be a plus quantity, and the follower will turn in the same direction as the driver; but if the denominator should be less, by one, than the numerator, the value of the expression would be minus and the follower would turn in the opposite direction to the driver.

Notation

N = number of turns of driver to one of follower or driven member;
N' = number of turns of follower to one of driver;
N_1 = number of turns of driver to one complete revolution of planet wheel axis;
N_2 = number of turns of follower to one complete revolution of planet wheel axis;
D = diameter of pitch circle of driver, if driver is a toothed wheel;
D_1 = diameter of pitch circle of follower, if follower is a toothed wheel;
D_2 = diameter of pitch circle of fixed wheel; and
D_3,D_4, etc., = diameters of pitch circles of planetary wheels.

Designing Package-wrapping Machinery

By ALBERT A. DOWD

IN designing mechanisms for folding paper, the first point to consider is the number of folds to be made, second, the quality, thickness, and flexibility of the paper, and third, the shape of the package that is to be wrapped or the finished form of the paper when completely folded. One type of modern printing press folds the paper, after printing, by drawing it over a highly polished V-shaped steel plate. From the small end of this plate the paper passes between rolls which crease it as required. The same principle is occasionally applied to other automatic machinery, but it is seldom possible to employ it for package-wrapping machines. The latter class of work generally necessitates duplicating the same movements that would be made by the fingers in wrapping the package by hand.

At *A*, Fig. 3, are shown three views of a box that is to be completely wrapped in paper, so that part *B* lies over *C* with the ends tucked in and folded, as shown at *D* and *E*. The wrapping sheet is of rectangular shape having a length *F* and a width *W*. When completely folded, the creasing and tucking in of the ends causes diagonal creases, as shown at *L*. In this problem, a piece of paper is first laid in position; then a box is placed on it at a given point; next, the box is wrapped in the paper, after which it is discharged from the machine.

In previous articles, we have considered the feeding of boxes and the feeding of paper, but the wrapping of paper in the form shown has not been discussed. Before designing the machine, it is best to make a diagram, such as shown in Fig. 1, illustrating the sequence of the folding operations and the various movements required.

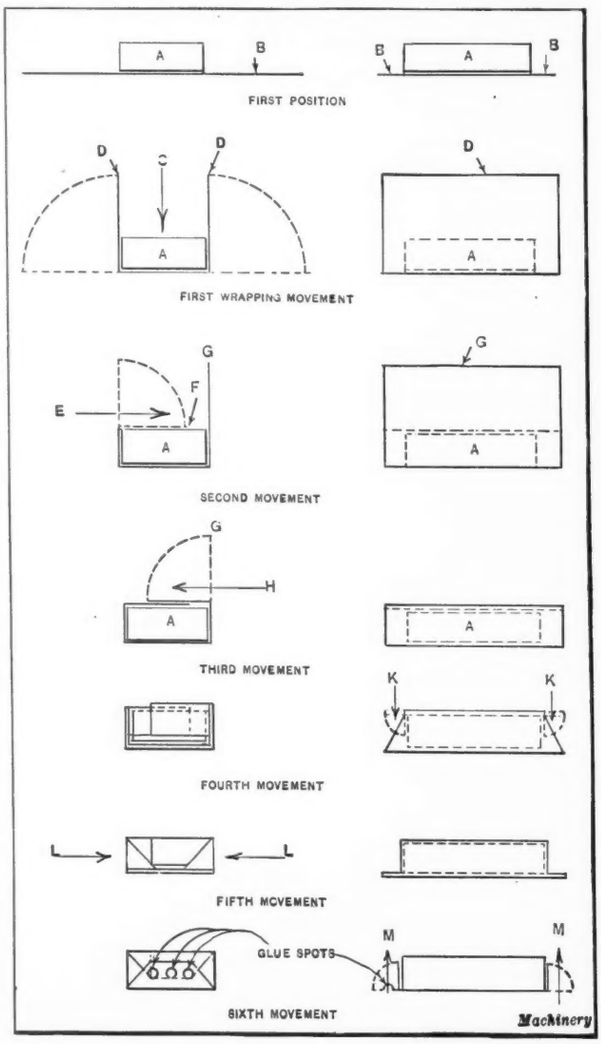


FIG. 1. Movements required in wrapping Package

After placing the box *A* on the paper *B*, the first wrapping movement will naturally be that of bringing up the two sides of the paper, as at *D*, by forcing the box between guides in the direction *C*. The second movement is to fold over one side *F* by carrying it in the direction *E*, leaving the portion of the sheet *G* upright. This is immediately followed by the third movement *H* which carries *G* down into position over the first fold. The fourth movement pushes down the two ends at *K*, and the fifth tucks in the sides by moving them in the direction *L*. The sixth movement folds the remaining paper up at the end of the box, as shown at *M*.

In planning the sequence of operations, we can make a diagram like that shown in Fig. 2, subject to possible future revision as the details are worked out. A station type machine is proposed, having a magazine at *A* containing the boxes, which are fed forward by a slide *B*, and picked up by vacuum at *C*. The slide is then withdrawn and the table indexed to the point *D*, where the paper is fed through rolls *E* and cut off by shears at *F*, after which the paper is pushed forward into position under the box at *G*. The table then indexes again, and the box drops on the paper and is carried downward for the first movement in wrapping at position *H*. Other movements take place at *K* and *L*, and the completed package is finally ejected into a chute at *M*.

Cam-controlled Wrapping Units

Fig. 5 shows a side and end view of one of the wrapping units. There are six of these, all alike, arranged on the table, as indicated in Fig. 2. The various movements required are controlled by cam rings, both overhead and underneath the table. The table consists of two built-up circular disks *A* and *B*, Fig. 5, one located above the other. On these two plates, or in them, are incorporated the slides and brackets by means of which the box and paper are handled. The box *C* is shown between the spring guides *D* and *E*, which hold it in the position indicated after it has been pushed down by the plunger *F*; the plunger also serves as a vacuum pick-up and an ejector. The first upper fold of the paper is made as shown at *G*, while the other side stands erect, as at *H*. On each side of the central slot, brackets are arranged, as at *K* and *L*, and these are so placed on the table that they leave the central slot open, permitting the various slides and plungers to operate without interference.

The side-folding slide *M* extends completely across between the two brackets *K* and *L*, and has a sliding bearing on each side at *N* and *O*. This construction allows the slide to move freely without rubbing on the face of the table, and there is little chance for dirt to enter the slide and cause trouble. The operation of the member *M* is through a lever O_1, pivoted on the rocker shaft *S*. At the center of the shaft is a lever *T*, at the upper end of which is a hardened ball point *P* which bears against the cam ring *Q*, the latter being supported by the circular casting *R*, carried on suitable brackets on the machine bed. The folding unit *M* at the right is timed to move forward and fold down the portion *H* as the other slide *M* at the left recedes.

End-folding Mechanism

The device used for making the first end fold in the paper is a double U-shaped slide, dovetailed at U to give a sliding bearing at the inner side of both the supporting brackets. The slide arches over, as shown at V, and carries at the center a roller W, the movement of which is controlled by the cam X. In operation, the plates Z move down and tuck in the projecting ends of the paper at A_1 and B_1, thus forming the first end fold. The tucking in of the remaining sides is done by the slides C_1 and D_1, these being dovetailed into the slot, as shown at E_1 and F_1. The operation of these slides is controlled by four levers, one of which is shown at G_1. Two of these levers are arranged on each side of the central slot. The lower end of each lever has a ball point which bears against the cam ring H_1; this cam ring lies under the table out of the way of all other mechanism. The central plunger I_1 is carried in a bracket J_1, which is screwed to the two side brackets K and L, as indicated, and serves also as a tie and spacer. It is relieved slightly at K_1 so that the dovetail sliding member will not rub. The operation of the central plunger is through a lever L_1, slotted at one end and connected at the other end with a short lever M_1 which has a ball at the end that bears against a cam n.

Particular attention is called to the arrangement of the cams on this machine, which are all of the fixed variety, operating as the table revolves. In several cases, they extend only part way around the table, being placed according to the requirements of the operation of the units that they control. The plunger I_1 has several movements during the revolution of the table. First it moves downward, and picks up the box, holding it in position while the paper is placed underneath. Next it pushes the box down to the position shown at C, making the first fold, and then rises and remains in the position indicated at F, until the discharge position is reached, at which time it pushes the completed package down into the chute.

Just previous to the final folding up of the ends of the package three glue spots are placed on the ends by reciprocating fingers at each side of the slot. These fingers collect glue from a pick-up roll underneath the table (not shown in the illustration). The final end fold is made at the time of ejection, when the box is pushed down by the plunger I_1 between the spring strips P_1 and Q_1. As this plunger is used as a vacuum pick-up, it is connected to an air pipe at R_1, the latter being flexibly connected to a central distributing collar.

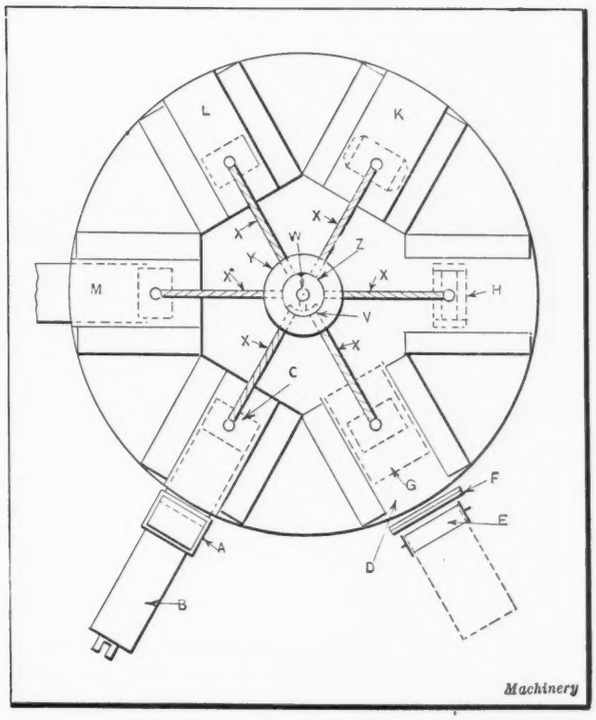


Fig. 2. Diagrammatic Lay-out of Box Feeding and Wrapping Machine

Vacuum Pick-up Device

In picking up the box from the magazine, it must be carried forward a considerable distance, and then lifted up and held stationary while the paper is inserted under it. The important details of the pick-up plunger are shown in Fig. 4. The boxes A lie in a vertical magazine and fall into the carrier B when the latter is withdrawn. The box is moved forward to the position C while supported by the extension of the carrier D. It is then sucked up against the perforated

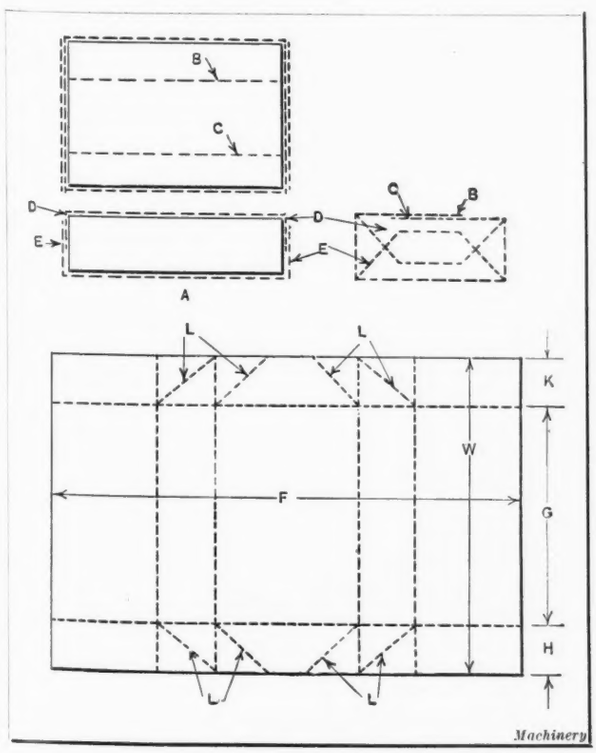


Fig. 3. Method of wrapping Paper around Boxes

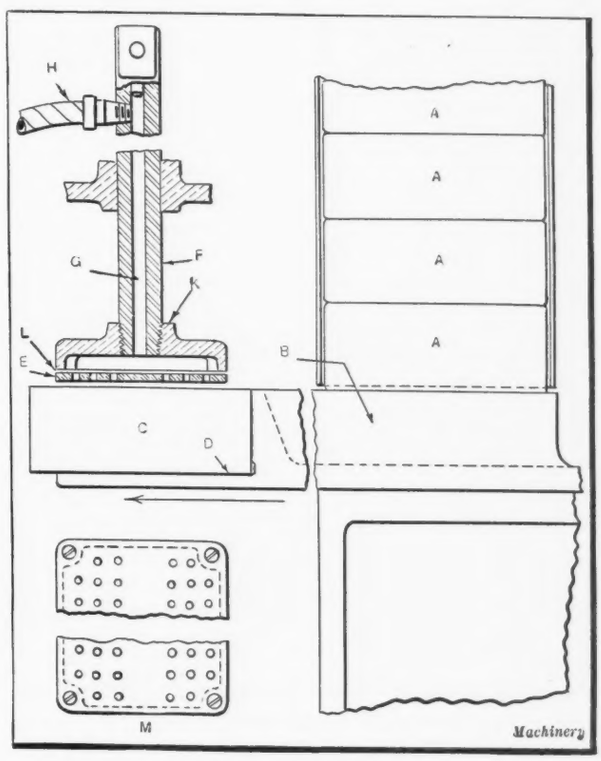


Fig. 4. Vacuum Pick-up and Box Carrier

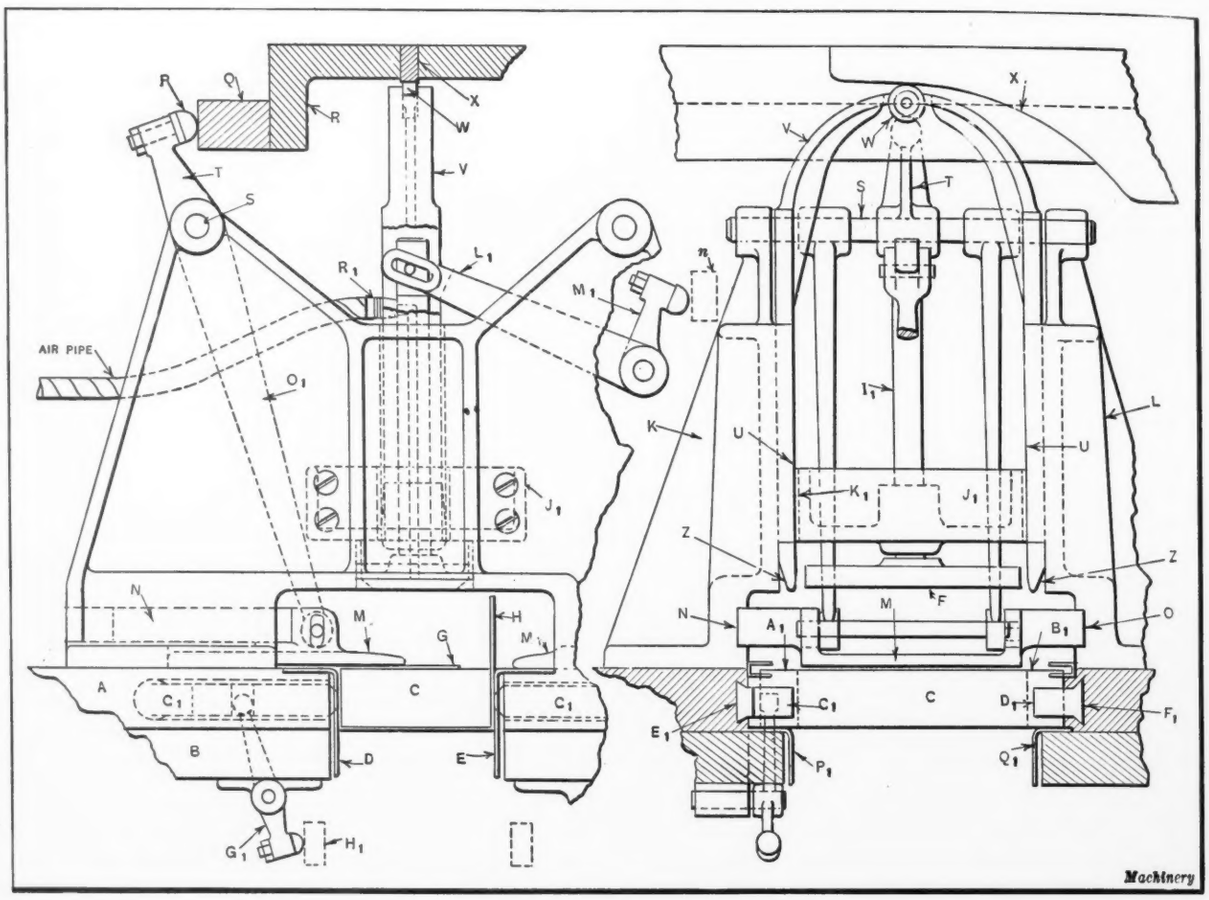


Fig. 5. Details of Wrapping Unit incorporated in Box Feeding and Wrapping Machine

plate *E* and held there while the carrier recedes. The plunger *F* has a small hole *G* through its center, and this hole connects with the flexible hose *H*, which is attached to the distributing collar. Referring to Fig. 2, there are six flexible tubes *X*, all of which enter the distributing collar *Y*. The collar *Z* is fixed, and leads through a pipe *W* to an air pump, so arranged as to produce a small amount of vacuum. Collar *Z* has a slotted circular outlet at *V*, this being so arranged that it covers a space slightly more than that taken by the movement from stations *A* to *D*. This allows the vacuum pick-up to operate and hold the box during this period of revolution of the table.

Referring again to Fig. 4, the plunger *F* is screwed into the bronze casting *K*, to the lower side of which is fastened a perforated plate *E*. A rubber gasket *L* is interposed between the two surfaces to make an air-tight joint. The method of perforating the plate is indicated in the plan view at *M*. The central portion has no perforations, as it is desirable to apply the holding force of the vacuum on the outer portions of the plate. It is important in using air under pressure or in forming a partial vacuum to make connections air-tight by using shellac or rubber cement. The amount of vacuum required is not great, but it should be sufficient to allow for leaks or other similar troubles.

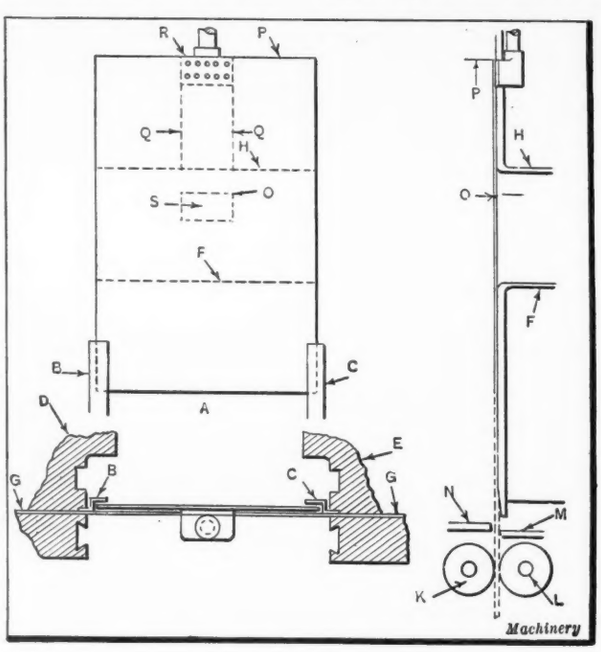


Fig. 6. Diagram illustrating Method of feeding Wrapper

In designing the wrapping machine, it was first suggested that cut sheets be used, and fed by a vacuum pick-up to the required position, but the brackets holding the folding units took up so much space that this was found impractical, particularly as it required a very long movement of the pick-up arm. A combination consisting of a roll feed, cut-off device, and vacuum locating device was finally employed, as indicated in the diagrams in Fig. 6. Referring to the plan view at *A*, sheet-metal guides were provided on each side at *B* and *C*, and the opening between the brackets *D* and *E* bridged up to the dotted line *F* by the steel plate *G*. A similar arrangement was also made from point *H* onward. The space between *F* and *H* is left open, and the plates are bent downward, as shown in the side view, so that they act as guides when the box is pushed down between them.

The paper is carried on a large roll and led between the feed-rolls *K* and *L*, which are adjustably mounted and geared together. Just beyond the feed-rolls is a fixed blade *M* and a movable one *N* which act as shears to cut off the paper to the required length. The cutting movement is controlled by a simple ratchet and pawl device. When the shears cut off the paper, the forward end lies at the point indicated by the arrow at *O*, and in order to bring it into the position required, this end must be moved forward to the point *P*.

The vacuum pick-up shown at *R* was finally designed to accomplish this. The rear plate lying between *H* and *P* was cut at *Q*, so that the vacuum pick-up *R* could move freely up to the point *S*, where it remains until the paper is fed up to point *O*. The vacuum plate then grips the paper from the under side while it is pulled backward to the position *P*. This movement is made while the table is being revolved from *G* to *H*, Fig. 2.

The paper is then ready for the box to be placed upon it. The pick-up is controlled by means of a cam-plate underneath the table, so arranged that the first movement of the connecting lever opens the valve, and a continuation of the movement gradually brings the paper into the required position. This controlling mechanism is not described in detail, as it is of a simple nature and can be readily worked out. It is understood, of course, that the air is cut off from the vacuum pick-up *R*, Fig. 6, as soon as the plunger drives the box down on the paper and through the opening between the steel strips *F* and *H*.

* * *

A report on training foremen has recently been published by the Metropolitan Life Insurance Co.'s Policyholders' Service Bureau, Metropolitan Building, New York City. The report is known as "Training Key Men in Industry," and points out the important part played by foremen in modern industrial organizations. The foreman's position as a link between management and employes is emphasized, and his part in reducing labor turnover, promoting and maintaining friendly feelings between the men and the firm, reducing costs, and eliminating waste is pointed out. The report further outlines the subjects that are recognized as valuable in the training of foremen, and gives a description of the methods that have been found best in this training, the foremen training practices of nine nationally known companies being described.

* * *

"All the world is riding in American motor vehicles," says a recent communication from the National Automobile Chamber of Commerce. "During the last five months, sixteen motor trucks were shipped to Greenland and seven passenger cars to Iceland, while Belgian Congo, in the heart of Africa, took twenty-nine passenger cars and eighty-seven trucks."

A JIG OF UNUSUAL SIZE

In automobile body building plants, large jigs are used for the assembling of the different parts of the body. These jigs are generally made from wood, and because of the impossibility of maintaining very accurate dimensions in a wooden jig, a great deal of fitting is required in assembling doors and other parts to the body.

At the Packard Motor Car Co.'s plant in Detroit, metal jigs have been constructed for the assembling of closed bodies, as shown in the accompanying illustrations. By means of these jigs, it is possible to assemble the bodies with such accuracy in the dimensions that practically no fitting is required. The doors, for example, will fit the assembled body perfectly at the first hanging. Another interesting result from the use of these jigs has been that greater demands have been placed upon the accuracy of the different parts entering into the body assembly. If the parts are to fit together properly when assembled in the metal jigs, they must be made within close predetermined limits, and in some instances the parts of wood in the body have to be finished with limits of accuracy that remind one of metal work.

The greater accuracy of the metal jig over the wood jig is due to the fact that the metal jig will not give. In the wood jig there was always a certain amount of "lost motion." The wooden parts would give slightly if the dimensions of the parts to be assembled were not within the prescribed limits; altogether, the accuracy obtainable with the metal jig was not possible in the older type. Incidentally, these are probably among the largest jigs used in any kind of manufacturing practice—possibly the very largest jigs constructed from metal for any purpose whatever. In addition to the convenience and cost-saving qualities of the jigs, they also provide for an improved quality of the car body, because of the assurance that all parts will fit together accurately and smoothly.

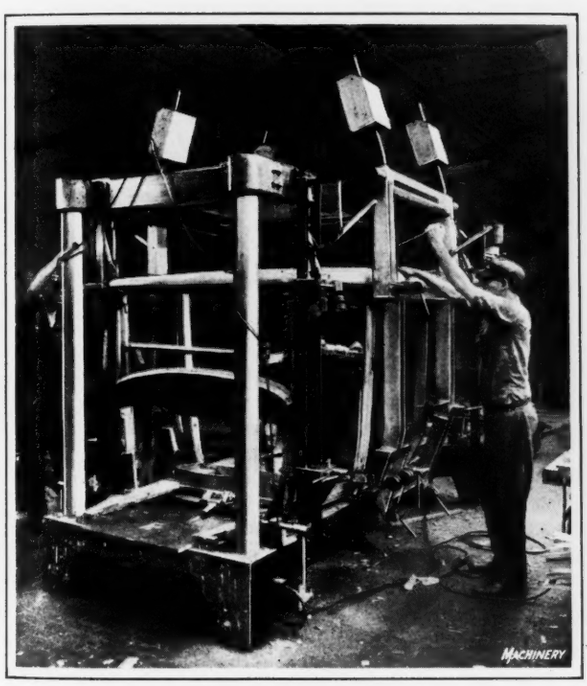


Fig. 1. Large Jig used for assembling Automobile Bodies at the Packard Plant

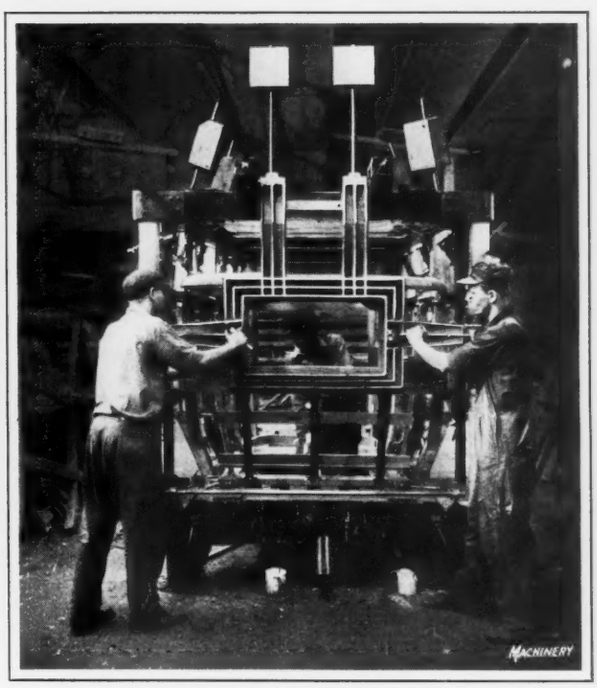


Fig. 2. Another View of the Large Automobile Assembling Jig shown in Fig. 1

* * *

The American Society of Mechanical Engineers will hold a Machine Shop Practice Session on Thursday, September 17, in Cleveland, Ohio, in conjunction with the exhibit of machine tools and heat-treating equipment held there during the week beginning September 14 under the auspices of the American Society for Steel Treating.

Tools and Fixtures in the Pierce-Arrow Plant

By CHARLES B. EKDAHL, Chief Tool Engineer, Pierce-Arrow Motor Car Co., Buffalo, N. Y.

TYPICAL operations in the cylinder line used at the Pierce-Arrow Motor Car Co., in manufacturing the new series 80 automobile were described in a preceding article which appeared in August MACHINERY. The present article will deal with a more varied selection of operations on the same type of car, in which fixtures or tooling of unusual design are employed.

In machining the aluminum oil-pan, use is made of the double fixture illustrated in Fig. 1 to perform two different operations on two separate parts with each set-up, using only one cutter. It will be seen that one pan is laid horizontally on the fixture, as shown at *A*, and the other is mounted vertically, as illustrated at *B*. When the table is fed past the milling cutter, surface *C* is milled on the horizontal pan and boss *D* on the vertical pan, the feed of the table being ended when the cutter completes the milling of the boss.

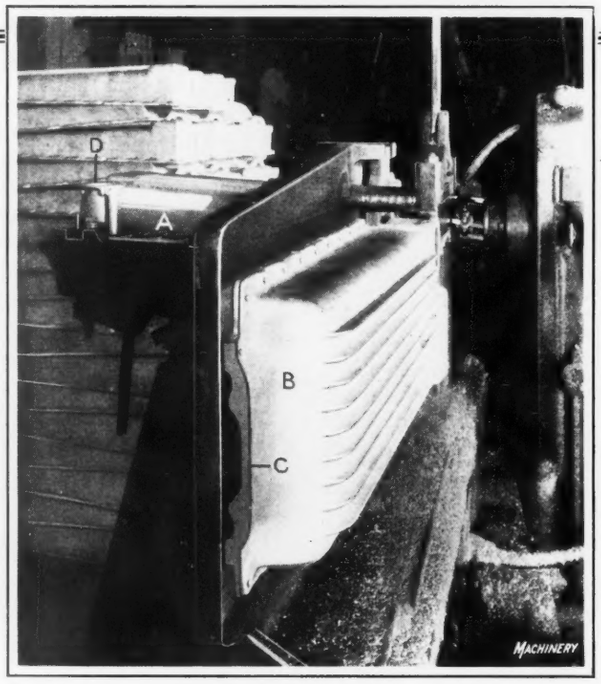


Fig. 1. Duplex Type of Fixture employed in performing Two Different Milling Operations on Two Automobile Oil-pans at One Time

Several quick-acting mechanisms are provided on this fixture for locating the work and holding it in position, as illustrated in Fig. 3. The vertical piece is supported on the lower edge by three pins *E*, and held to the fixture by two clamps *F*, one at the top and one at the bottom, each of which has two holding lugs. When the oil-pan has been slid into place between these clamps and the fixture proper, the two clamps are simultaneously tightened by means of handle *G* on the front of the fixture, as illustrated in section *A*–*A*. The swiveling end of this handle comprises a cam which bears on a pin, and hence, as the handle is turned, bracket *H* is pulled away from the fixture.

At each end of this bracket is a bolt *I* connecting the bracket to a corresponding clamp *F*, which is thus pulled firmly against the work. Each clamp swivels on a rounded surface *X* of the fixture, and is equipped with a spring that pushes it away from the work when handle *G* is loosened. Endwise location of the oil-pan is obtained by abutting the end nearest to the cutter against a shoulder on the fixture.

The front end of the horizontal oil-pan is located both endwise and sidewise by means of two dowel-pins which are entered into two previously machined holes in the pan. The front end of the oil-pan is held in position by operating handle *K*, which is of a cam design and forces stud *L* down on bar *M*. This bar then acts in a similar manner on the upper end of pressure pins *J*. Two clamps at the rear end of the oil-pan are operated the same as clamps *F*, to hold the pan firmly at this end.

Much time was formerly spent applying surface gages and other measuring and indicating devices to the rough crankcase castings to determine whether there was sufficient stock at all points to enable the parts to be machined to specifications. This time has been greatly reduced by the use of the target fixture shown in Fig. 2, by means of which the amount of stock is visually determined on twenty-two different surfaces. Thus if a crankcase is distorted beyond the point of usefulness, or if it is under size at any point, it can be discarded before machining has been performed on it. After the inspection, but while the crankcase is still in the fixture, four bosses on the motor support arms are accurately drilled for center distance and faced for height. These holes and faced surfaces are used for locating purposes through all the succeeding milling operations.

The fixture consists primarily of a base *A*, with a hinged bracket at each end. These brackets must be swung open to permit seating the casting in the jig. One of the brackets is shown in the open position at *B*, and the other closed at *C*. They are locked in the closed position by operating a handle *D* on each bracket, which causes rods to enter sidewise in hardened steel bushings in uprights *E* at the front and rear. Two rods are operated simultaneously by each handle *D*, as the shaft actuated by this handle has two cams, one contacting with the inner end of the rod extending to the front of the jig, and the other with the rod extending to the rear.

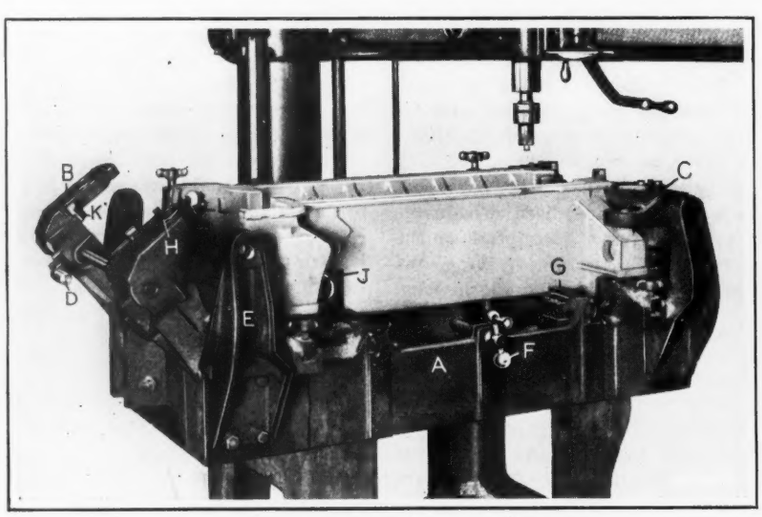


Fig. 2. Target Fixture used for determining whether there is Sufficient Metal at Twenty-two Different Points on the Crankcase for Subsequent Machining Operations

At the center of the fixture are two jaws which are gripped on the sides of the central main crankshaft bearing

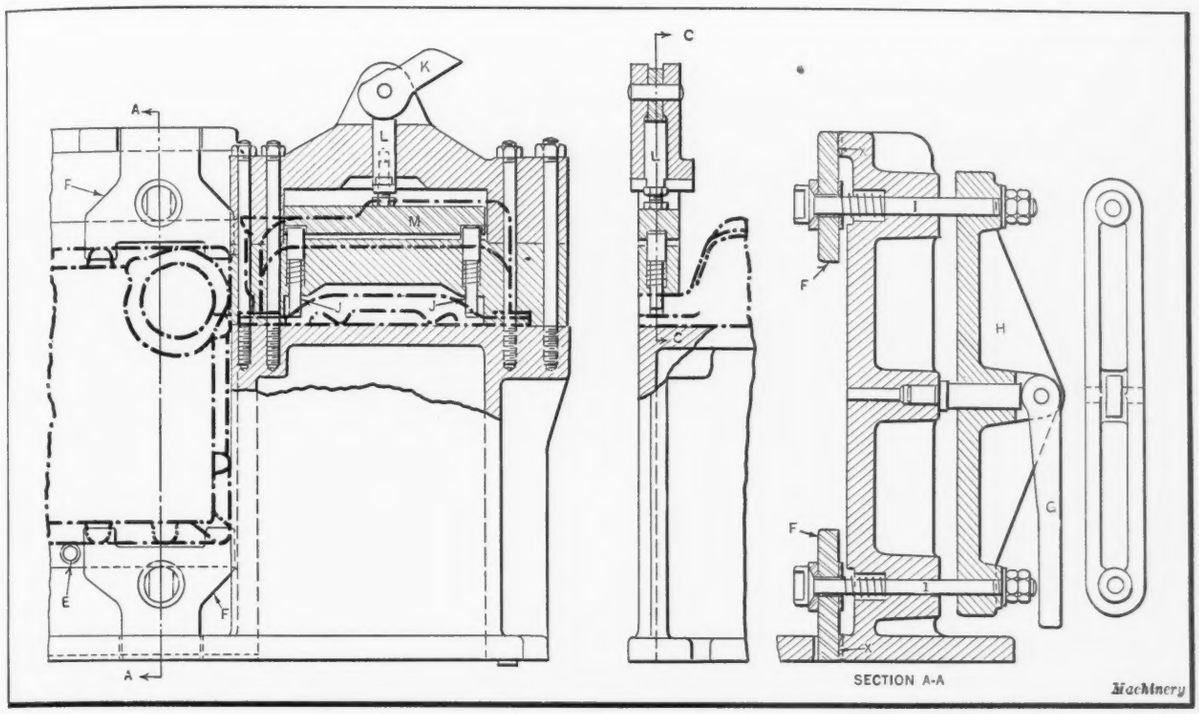


Fig. 3. Mechanisms embodied in the Oil-pan Fixture for locating the Work and clamping it in Position

when handle *F* is turned. Turning this handle forces a wedge between the lower ends of the two jaws and causes them to swivel at a central point and rock the upper ends down on the work. These jaws centralize the crankcase approximately lengthwise, while four jaw clamps *G* locate it sidewise. The case is held down by means of two removable clamps, each of which has a socket with a bayonet lock which can be conveniently attached to a short post on either side of the central clamps. The removable clamps have square plates at the top which are tightened on surfaces of the crankcase.

When the crankcase is laid in the fixture, it rests on four arms which are adjustable for height so that the casting can be raised or lowered until an approximately uniform amount of stock will be removed from all surfaces to be machined. This method avoids excessively thin or thick sections anywhere, such as would occur with a less satisfactory method of locating for drilling and facing the motor support arms. When the crankcase has been suitably positioned, the cutter in the spindle of the drill head is fed through two bushings *H* on brackets *B* and *C* to drill and spot-face, as mentioned. There is an adjustable stop-collar on the drill spindle, which is set to face the bosses to a predetermined height.

Of the twenty-two bracket surfaces, eight are contained on one hinged member, ten on the other, and the remaining four on the base. With this construction, the loading and unloading time is reduced, as practically all movable parts are incorporated in two units. At *J* is a block with a large hole in it, which is used for determining the amount of stock provided for machining the pump pad and hole. Two blocks *K* are furnished on each hinged bracket for checking the length of the crankcase. Still another inspection block is seen at *L*.

Milling and Boring Operations on the Crankcase

Seven bearings in the crankcase are simultaneously milled for length by means of the set-up illustrated in Fig. 4, which shows a Moline drilling machine equipped with a special head that supports and drives a horizontal bar on which fourteen cutters are mounted. The drive to the horizontal bar is through pulley *A*, and is standard to this point. On the same shaft as that on which pulley *A* is mounted is a spur gear that drives the cutter-arbor through a second gear

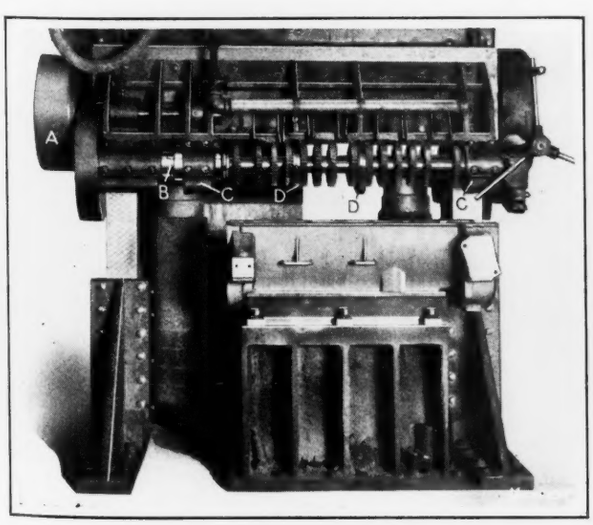


Fig. 4. Set-up in which Fourteen Cutters are used simultaneously for milling Seven Bearings of the Crankcase

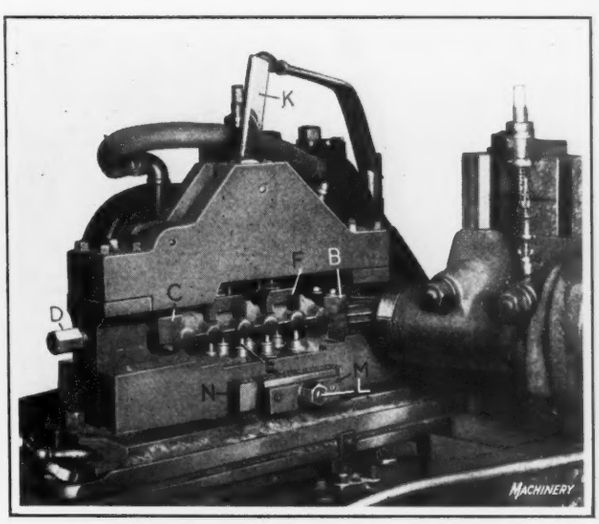


Fig. 5. Fixture equipped with Equalizing Supports and Clamps that eliminate springing of a Fragile Casting

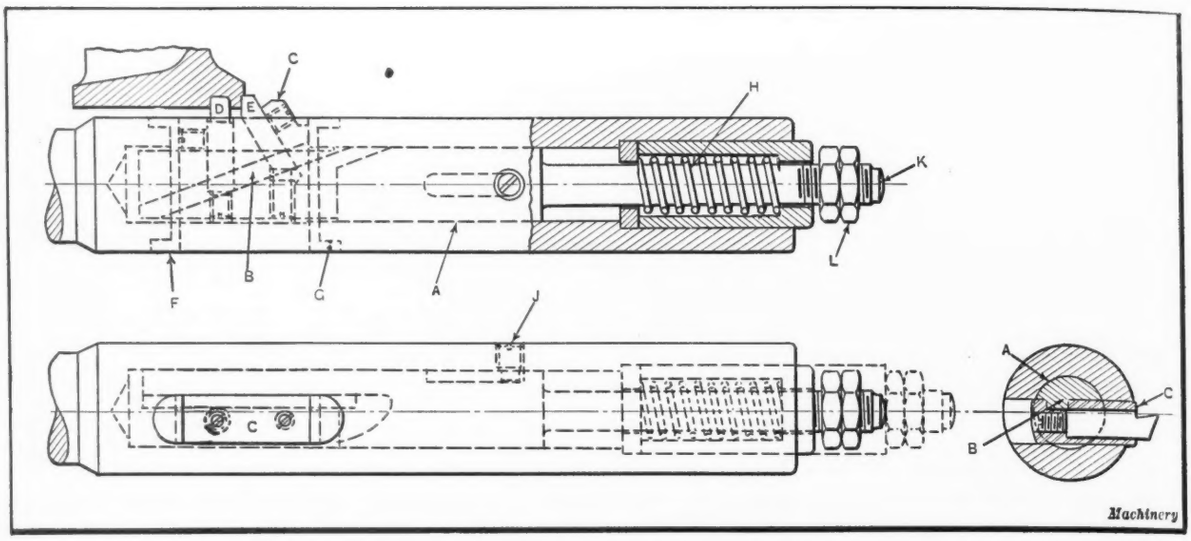


Fig. 6. Construction of One End of a Long Boring-bar holding Recessing and Facing Tools that must be expanded radially for the Operation and contracted to withdraw the Bar from the Work

mounted at the left-hand end of the arbor. A feature of the arbor is that it is made in two sections which are interlocked at *B*. Thus much time can be saved when it is necessary to change the cutters, because the cutter portion of the arbor can be quickly disassembled from the driving portion by simply taking off the four caps *C* and *D*. Three arbors and sets of cutters are kept on hand ready for use.

The operation is performed by simply feeding the head down in the standard manner. Copious lubrication is supplied from an overhead pipe, fitted with vertical tubes extending to each cutter. The work-holding fixture is mounted on a slide which may be adjusted horizontally on the base. Accurate location of the work in this fixture is insured by two dowel-pins, and the work is held firmly by four clamps.

All seven crankshaft bearings are bored by means of one bar 71 inches long, which is also used for recessing and facing the rear bearing. Nine tools are used for boring the different bearings, these tools being of a flat, rectangular-section type held in place by wedges. After an operation, they can be conveniently knocked out of the bar to permit removing the bar without scarring the newly bored bearings. The tools used for recessing and facing the rear bearing, however, are of a special design, requiring to be expanded after the bar has been fed to depth and contracted before removing the bar. The method of operating these tools will be understood by reference to Fig. 6.

It will be seen that the rear end of the bar is bored out to receive plunger *A*, which is milled flat at the forward end

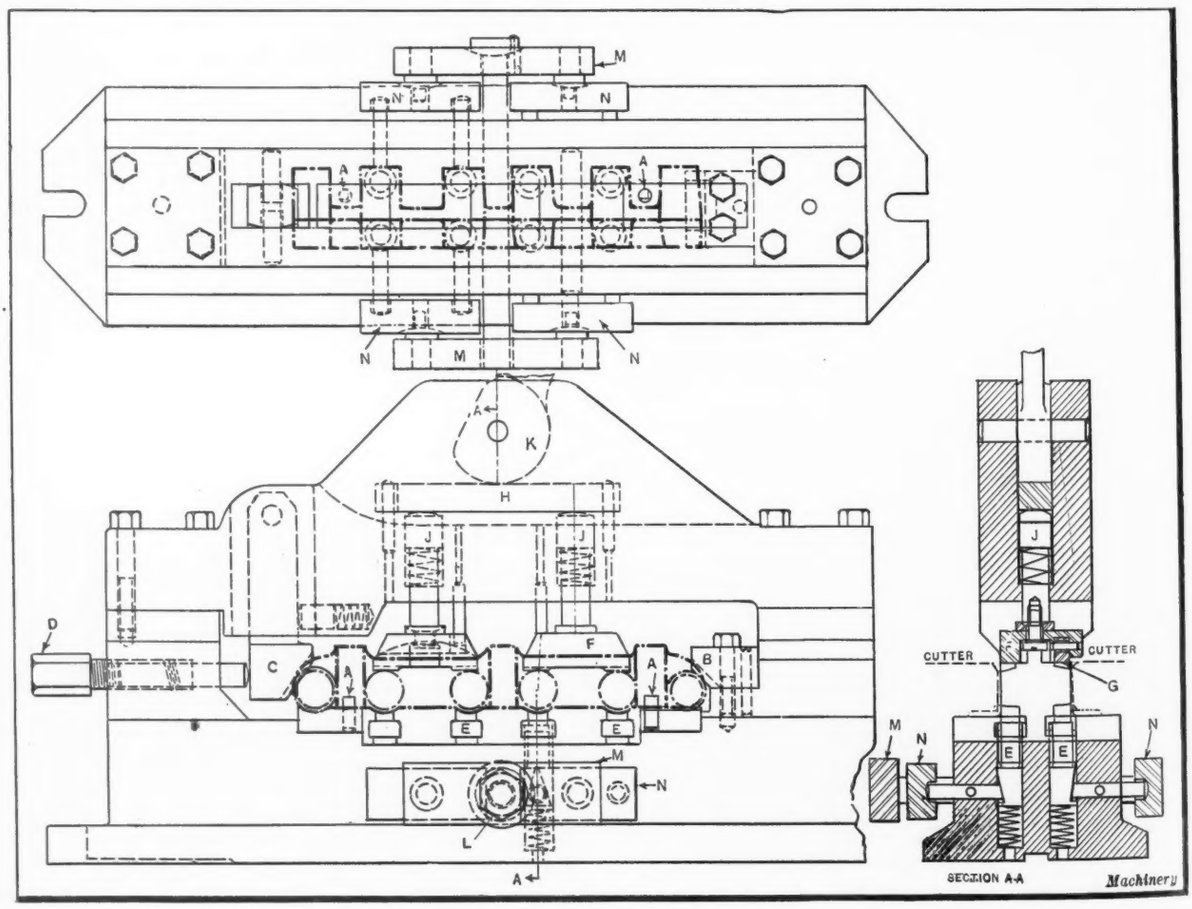


Fig. 7. Details of the Valve-lifter Guide Bracket Fixture shown in Fig. 5

except for a tongue *B* extending from the bottom forward end of the flat surface to the upper right-hand end. Tool-holder *C* is provided with a slot milled to seat on this tongue, the tool-holder being contained in a slot that extends transversely through the entire bar. When the boring-bar has been fed to depth, a lever on the fixture is applied against end *K* of the plunger, forcing the plunger forward and causing tool-block *C* to be expanded outward as tongue *B* is moved horizontally relative to the slot in the tool-holder. Obviously, tool *D* is for recessing, and tool *E* for facing the bearing to a diameter slightly larger than the oil-ring. When the pressure on end *K* is released, spring *H* returns the plunger to its original position, and tool-holder *C* is then drawn back into the bar. The maximum cutting diameter of the tools can be adjusted through nuts *L*, and there is also an individual adjusting screw for each tool. Screw *J* limits the longitudinal movements of the plunger. Parts *F* and *G* are hardened and ground steel guides for the tool-holder. In this recessing and facing step, the bar is held in position endwise by means of a removable stop bearing against the front housing of the fixture.

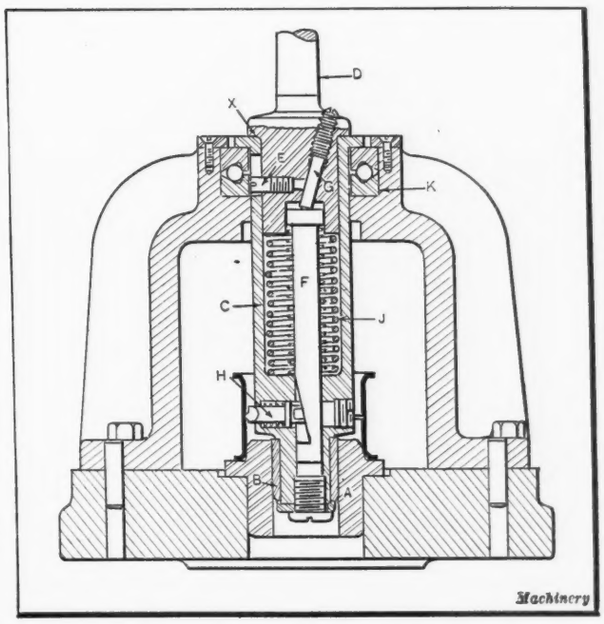


Fig. 8. Tooling developed for cutting a Ring Groove at an Angle in the Crankpin Bearing of Connecting-rods

Cutting an Oil-groove in Connecting-rods

In the crankpin bearing of the connecting-rods is a circular oil-groove cut at an angle so as to distribute lubricant more efficiently than if it were straight. This groove is cut by means of the tooling shown in Fig. 8. The crankpin end is seated on plug *A*, and the piston-pin end on another plug at the back of the fixture, which is at a certain height that results in the groove being cut at the desired angle by a tool revolving in a horizontal plane. Sleeve *B* on the lower end of the tool is a running fit in plug *A*. Holder *C*, which contains the grooving tool *H*, is separate from shank *D*, so that the holder can be held stationary vertically, and the shank raised and lowered. Disconnection of the shank from the holder is prevented by stud *E*, the head of which operates in a closed slot in the holder.

When a connecting-rod has been placed in the fixture, the operation is started by feeding down on shank *D*, which is attached to the spindle of a drilling machine. As the shank is lowered, it contracts spring *J*, permitting stud *G* to depress rod *F*, which is located somewhat off the center of the shank and sleeve *B*. Simultaneously with the feeding downward of rod *F*, the wedge surface near the lower end of the rod forces tool *H* radially outward to groove the crank-pin bearing as the tool is revolved. When the shank is lifted, the rod is also raised by the small-diameter coil spring surrounding it, and the tool is drawn back by the spring that surrounds it.

The depth of cut taken by the tool can be varied by adjusting stud *G*, while the position of the cut relative to the connecting-rod bearing is governed by the shoulder on the shank contacting with the holder at *X*. Easy rotation of the tool is insured by the large ball bearing *K*. Chips are prevented from getting into this ball bearing by the outer plate and by the shoulder on holder *C*.

Milling the Valve-lifter Guide

Several unusual fixtures are used in milling, drilling, and reaming the valve-lifter guide bracket. One used in milling the bosses in a duplex machine that applies a face milling cutter simultaneously on each side of the part is shown in Figs. 5 and 7. There are six bosses on each side of this fragile casting, and it is necessary that the various supporting and clamping members be equalized so as not to spring the casting. When the part is placed in the fixture, it is approximately located by two pins *A*, which register against the under side of the rib, and by the stationary block *B* and the hinged block *C*. The latter swings from the upper end and is forced against the work by tightening bolt *D*.

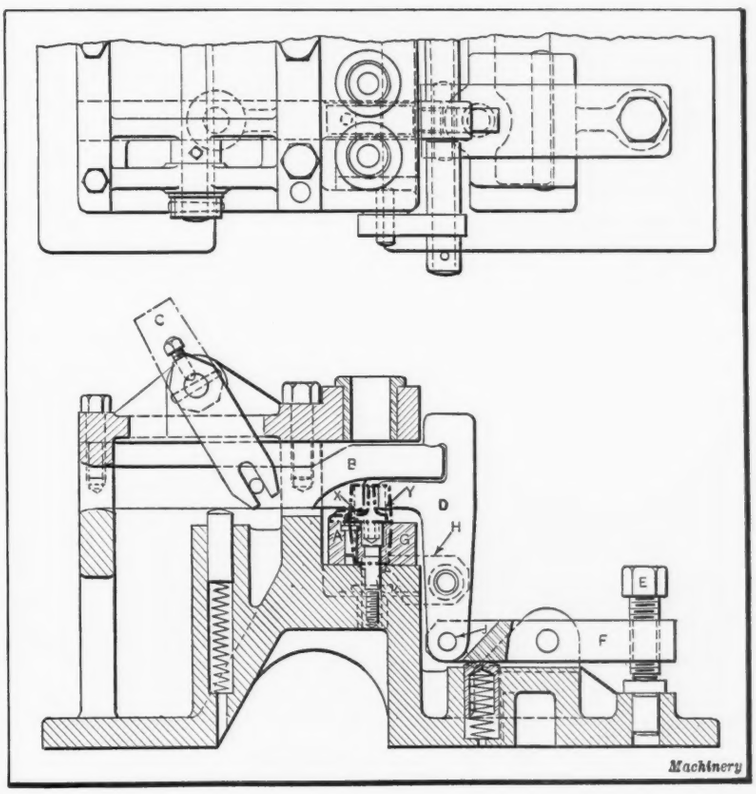


Fig. 9. Unusual Clamping Methods embodied in a Jig for reaming the Valve-lifter Guides

Beneath the four central bosses on each side of the work are plugs *E* which are spring-actuated to make them all contact with the work. There are two blocks *F*, each of which has four points that register on four different bosses above the plugs *E*. Two swivel pads *G* are provided on one side of these blocks, and the blocks themselves swivel so that an equal pressure can be exerted on all the bosses on which the blocks are clamped.

Each block *F* is held by a plug *J*, which is contained in an overhead housing and comes in contact at the upper end with

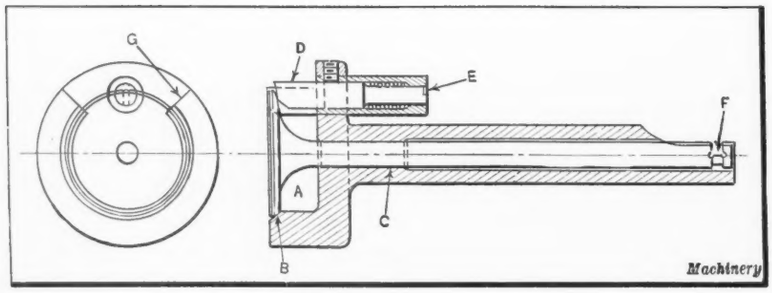


Fig. 10. Gage used for inspecting the Tappet Valves

a bar *H*. When pressure is applied on bar *H* by operating handle *K*, which has a cam at the swivel end, blocks *F* are tightened on the work. Bar *H* can readily adjust itself to suit a difference in the height of the two plugs due to unevenness in the casting. Before handle *K* is raised, nut *L* is tightened to draw in plates *M* on each side of the fixture, and also equalizing plates *N*. Plates *N* force the wedge-shaped ends of pins *O* against corresponding surfaces on plugs *E*, as shown in section *A*–*A*, and thus lock the plugs in position to support the valve-lifter guide during the milling operation.

Boring and Reaming the Holes in the Valve-lifter Guide

As this valve-lifter guide is made in right- and left-hand styles, difficulties were encountered when it came to designing jigs that would handle each style in boring and reaming the guide holes. Fig. 9 shows a sectional view of the boring jig; the reaming jig is of practically the same design. The part is held in this jig with the axes of the bosses vertical, as indicated by the heavy dot-and-dash lines. It is located from holes previously drilled in the flange, which are seated over three plugs *A*.

When the jig is arranged for boring a part of the hand indicated, three bars *B*, located centrally between the first and second, third and fourth, and fifth and sixth bosses, are pushed forward by operating three levers *C* on a shaft that runs the whole length of the fixture. Three links *D*, which swivel on pins *J*, are next lifted by hand to lock the upper end over the front end of bars *B*, as shown. Then bolts *E* are turned to raise the outer end of links *F* and pull down the inner ends and also links *D*. Links *D*, in turn, pull down bars *B*, so that a rounded surface *X* on each bar clamps firmly on the work. When the operation is completed, bolts *E* are simply unscrewed, links *D* thrown forward from bars *B*, and handle *C* operated to return the bars to the back position.

In using the jig for boring parts of the opposite hand, bars *B* are not used, being kept in the back position. Plates *G*, which contain plugs *A*, are reversed on the jig base, with the plugs in front of the center line of the bushings. In this case, when links *D* are raised, two blocks *H* on a shaft that runs across the jig through all links *D*, are located over pins at the ends of the jig to hold the links vertically. Then, when bolts *E* are tightened, a rounded surface *Y* on each link *D* is pulled down on the flange of the work, holding it firmly for the operation.

Gage for Tappet Valves

In producing the tappet valves, particular stress is laid on getting the diameter and angle of the seat accurate within a very close tolerance. The gage illustrated in Fig. 10 was designed for checking the over-all length, the location of the neck in the tappet end, the location of the top surface of the head, the angle of the seat, and the thickness of the flange. The large end of the gage is counterbored at *A* to a depth of 3/4 inch, and is chamfered at *B* to correspond to the valve seat in the cylinder block. Hole *C* is so made that the valve stem will fit snugly.

By pressing the valve against chamfer *B*, the gage-pin *D* is pushed back to give a reading at *E*, where there is a step 0.010 inch high, within plus or minus, 0.0005 inch, that is referred to a ground surface on the gage. It will be evident that with this small tolerance at *E*, only a very small tolerance is allowed on the diameter of the part where the under side of the head meets the bevel surface. The rim at the upper end of the gage is cut away 90 degrees at *G*, to permit a visual inspection of the contact between the seats of the valve and gage. The over-all length of the valve is checked by observing the position of the two ends relative to the ends of the gage. Slot *F* is employed for determining the location of the neck in the tappet end of the valve stem.

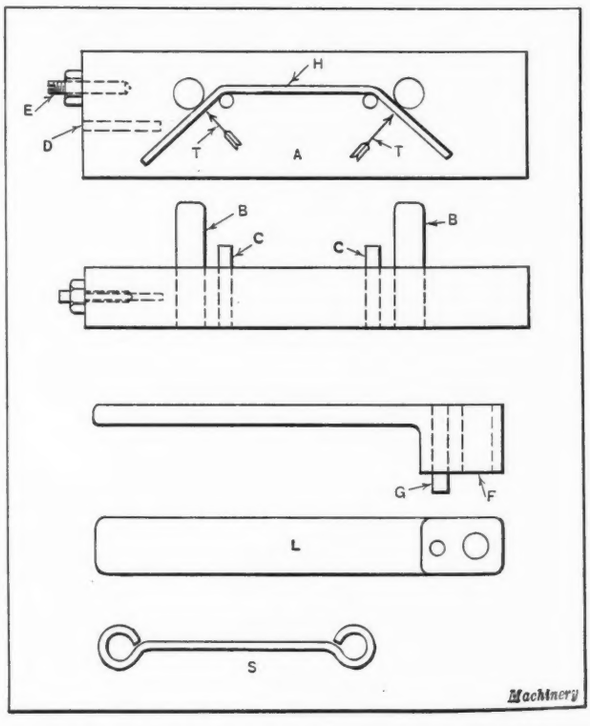
* * *

FIXTURE FOR FORMING WIRE LINKS

By S. W. BROWN

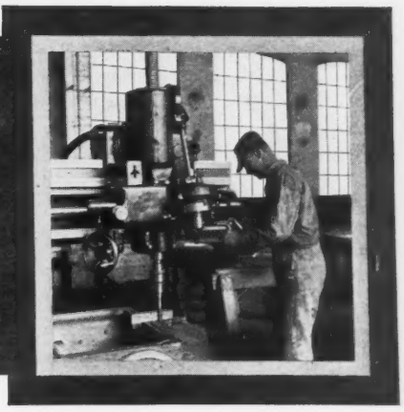
An inexpensive but effective fixture for forming eyes or loops in wire links is shown in the accompanying illustration. This fixture is designed to be held in a bench vise, and consists primarily of the block *A* into which are fitted two pins *B*. The distance between the centers of these pins is equal to the distance between the centers of the loops or eyes to be formed in the link. Two pins *C* locate the wire centrally with the eyes. A hole *D* is drilled in the end of the block, in which the wire is inserted and bent until it comes in contact with the adjustable stop *E*. The carrier *L*, which is used for forming the link eyes around the pins *B*, has a carrying pin *G* and is drilled as illustrated at *F* to fit the pins *B*.

The process of making wire links is as follows: First cut off the wire to the developed length of the link. Next insert one end of the wire in hole *D* and bend the wire until it touches stop *E*. Then repeat this bending operation at the opposite end of the wire, being careful to keep the bends in the same plane so that the partly formed link will lie flat in the fixture. At this stage of the forming operation, the link is shaped as shown at *H*. The carrier *L* is then placed in position on one of the pins *B*, so that pin *G* engages the wire at a point indicated by the arrows *T*. The eye is then formed by rotating carrier *L* about pin *B*, after which the forming operation is repeated at the other end of the wire, thus producing the complete link shown at *S*.



Fixture and Carrier Lever used in forming Eyes on Wire Links

Letters on Practical Subjects



THREADING MACHINE MADE FROM OLD TURRET LATHE

The writer was recently confronted with the problem of threading iron rods on a production basis. The rods were ordered in lots of various diameters and lengths, and were required to be threaded on both ends. A careful examination of the various machines in the shop showed that not one was adapted to the operation of threading both ends of a rod at one setting. Finally, an old turret lathe which otherwise would have been sent to the scrap yard was fitted up to handle the job.

All the unnecessary parts were removed from the lathe, and equipment was provided which permitted a rod to be threaded on both ends without unclamping it from the holding member. This was done by holding the work in the turret. After threading one end, the turret was indexed one-half revolution, in order to bring the opposite end into position for threading. The threaded cap *H*, Fig. 1, was machined to fit the shank of the self-opening die-head *K*. The rod *L*, which extends through the toolpost, was cut away, and a piece *M* secured to the ends, as indicated in the section *X*–*X*. A bushing *N* of the required size was then passed through the toolpost, and clamped in place by the bolt *A*. The rod *O* to be threaded is clamped in bushing *N* by means of the screw *P*, the end of which passes through a slot in the bushing. The guide plate *R* is attached to the lathe bed and supports the interchangeable bushings that center the work with the thread-cutting die. The guide bushings are located as near the threading die as it is possible to have them without interfering with the operation of the self-opening mechanism.

As the die-head could be closed only by revolving it in the direction in which it turns while threading, a special arrangement was required, which consists of the eccentric *T*, attached to the body of the die-head by set-screws, and a swinging member *U*, mounted on one end of eccentric *T* in such a position that it is always in contact with stud *V* in the die-head. Now if lever *U* meets with sufficient resistance while the spindle is revolving, stud *V* will be turned in the direction in which the spindle rotates, thus closing the die-head. The roller *Y*, mounted on the hand-operated slide *W*, serves as a trip for the swinging member *U*. Thus, when the operator desires to close the die-head, he simply moves lever *C* far enough to the right to bring the roller *Y* into contact with the member *U*. As soon as the die is set, the operator releases lever *C*, and spring *B* causes slide *W* to move to the left.

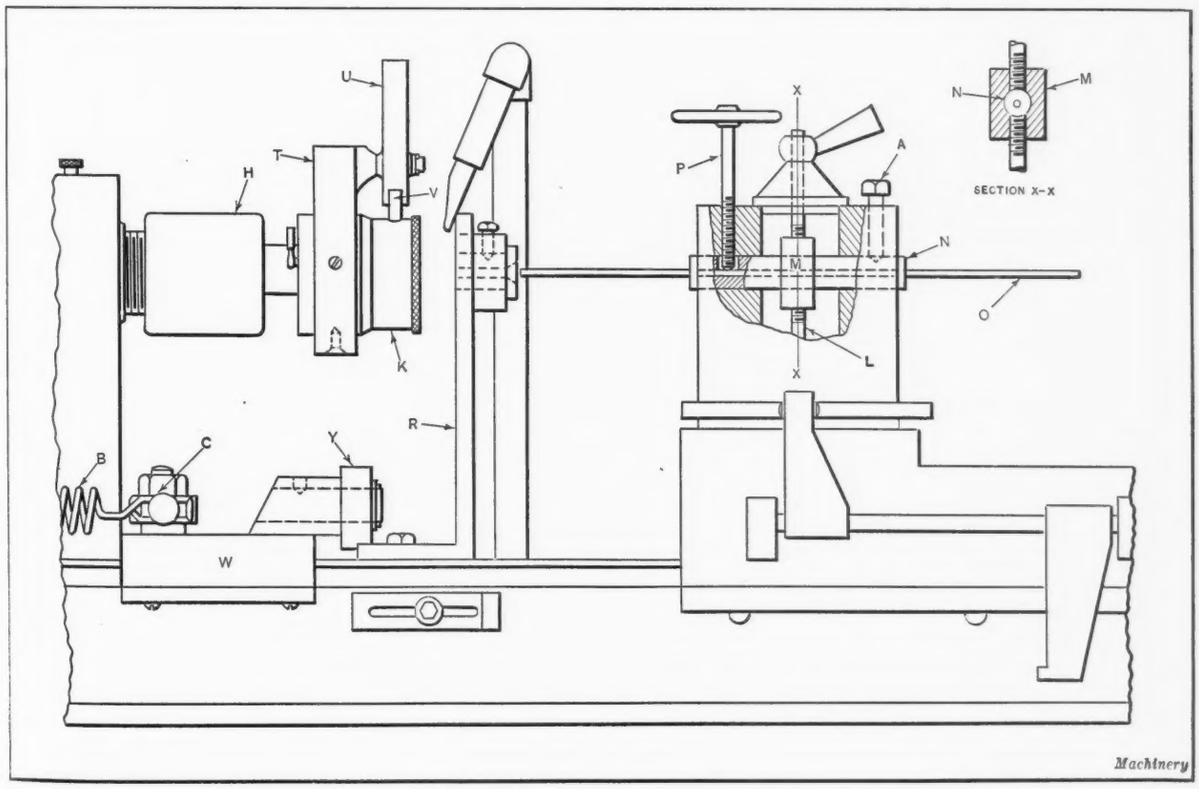


Fig. 1. Turret Lathe Equipment used in threading Rods on Both Ends

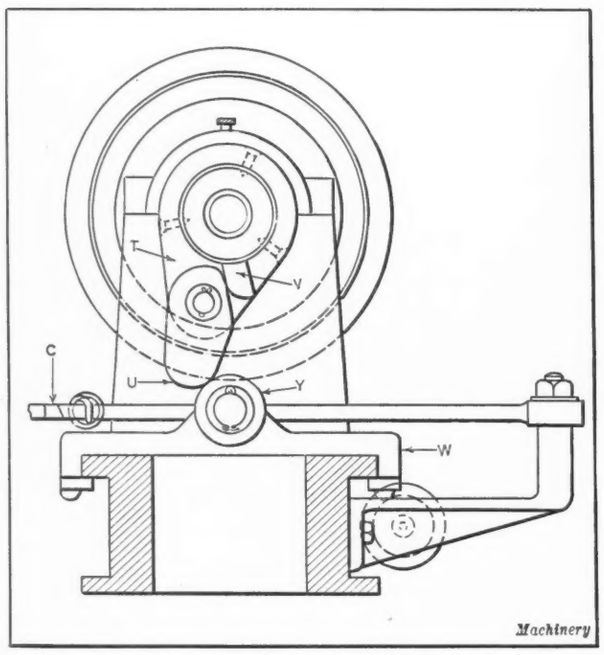


Fig. 2. End View of Equipment shown in Fig. 1

The operation of threading the ends of a rod is performed in the following manner: The operator picks up a rod with his right hand and slides it through bushing *N* until it is stopped by the guide bushing in plate *R*. Screw *P* is then tightened to hold the work in place, and slide *W* is brought forward by means of the lever *C*, as previously explained. As soon as the operator hears the die-head click shut, he removes his hand from lever *C*. Then the turret is fed forward until the adjustable stop prevents further movement. The turret-slide is held in this position until the die-head opens, after which the turret-slide is withdrawn and indexed 180 degrees. The other end of the rod is threaded in the same manner as the first end, after which the rod is removed from the holder and a new rod clamped in its place. The production rate on rods 3/8 inch in diameter, threaded for a length of 1 inch on each end, is from ninety-two to ninety-six pieces per hour.

Nijmegen, Holland H. C. TEN HORN

PLANNING WIRE-FORMING OPERATIONS

The diagrams shown in the accompanying illustration represent a preliminary study of the operations required on a wire-forming machine in the manufacture of the part shown by the heavy dot-and-dash lines at *T*. The view in the upper left-hand corner shows the initial operation. The wire is fed from a coil through straightening rolls by a feed-slide in the direction indicated by arrow *A*, and is cut off by the blade *G* which slides across the end of the hardened steel bushing *F* in the direction indicated by arrow *B*. The wire is fed against stop *D*, and the forming member *H* is advanced in the direction indicated by arrow *C* until it comes in contact with the wire, while a forming block *I* advances from the opposite side in the direction indicated by arrow *E*. These slides advance just previous to the cutting-off operation and hold the wire in place while it is being cut off by blade *G*. Arbor *H* then continues to advance and form the wire to the shape shown in the view at the upper right-hand corner of the illustration.

The sliding form *J*, which is next fed inward, bends the ends of the wire to the position shown in the view designated "third operation." The members *H*, *I*, and *J* then dwell, or remain stationary, while two revolvable arbors *K* and *L* which have protruding pins *M* and *N* and projecting central bending pins, rise into the positions indicated in the fifth operation diagram. Arbors *K* and *L* are then revolved by means of gearing in the direction indicated by the arrows *O*, thus twisting the ends of the work into the shape indicated in the fourth operation diagram.

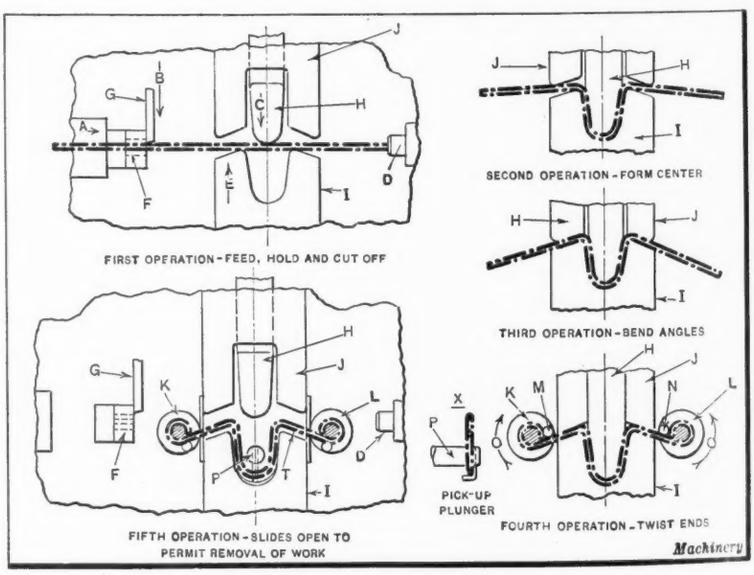
The work is removed by means of a rod *P* which descends from the top and automatically moves forward in such a manner that it becomes hooked under the wire, as indicated in the view at *X*. As soon as the pick-up rod is in position to remove the part, the member *H*, slide *J*, and slide *I* recede, and the members *K* and *L* move downward. The pick-up rod *P* then lifts the work from the machine, swings it to one side, and drops it through a hole in the frame of the machine into a box. The cycle of operations is then repeated automatically at a high rate of speed. If the operations, as worked out in the preliminary diagrams, cannot be performed on a standard wire-forming machine, a special machine may be constructed, following the lay-outs indicated in the diagrams.

Holyoke, Mass. FRANK H. MAYOH

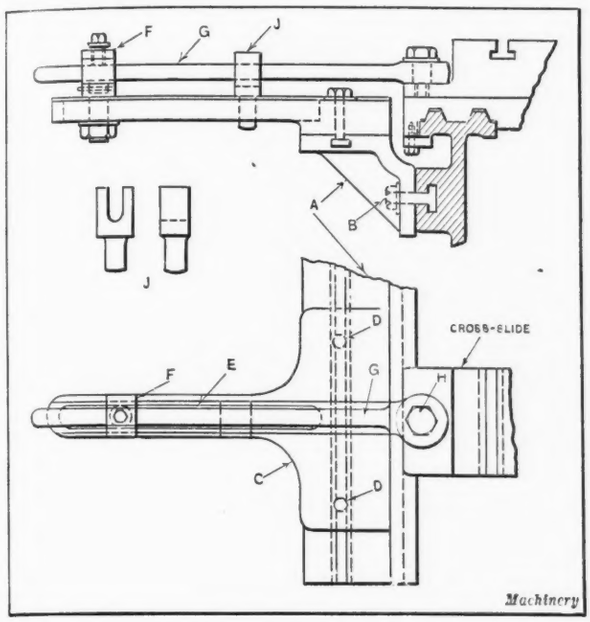
RADIUS TURNING ATTACHMENT

In the accompanying illustration, is shown a lathe attachment designed for radius turning. The cast-iron bracket *A* of the attachment is secured to the rear part of the lathe bed by two bolts, one of which is shown at *B*. Along the upper face of bracket *A* is a T-slot into which fits the tongue of bracket *C*. The latter bracket is held in place by two T-head bolts *D*. Bracket *C* has a 1-inch slot machined along the center, into which is fitted the swivel clamping post *F*. The connecting-rod *G*, which is held at one end by the set-screw in the top of post *F*, is secured to the rear end of the bottom slide by the stud *H*. Thus the cross-slide will be fed in when the carriage is moved either to the right or left, the proportion between the rate of cross-feed and longitudinal travel being such that the work is turned to the required radius. The setting block *J* is provided to enable the workman to set the cutting point of the tool central with the work when at the highest point of the radius, as for instance the center of the crowned face of a pulley.

Block *J* is made exactly the same width as the step on bracket *C*. In setting up the attachment, bracket *C* is moved along *A* into a suitable position, and then clamped down. Rod *G* is then swung around by moving the saddle along the bed until it lies on the center line of bracket *C*. This position is obtained when the sides of setting block *J* lie flush with the step on bracket *C*. Following this operation,


FIRST OPERATION - FEED, HOLD AND CUT OFF
SECOND OPERATION - FORM CENTER
THIRD OPERATION - BEND ANGLES
FIFTH OPERATION - SLIDES OPEN TO PERMIT REMOVAL OF WORK
PICK-UP PLUNGER
FOURTH OPERATION - TWIST ENDS
Machinery

Preliminary Plans for Wire-forming Operations



Lathe Attachment for Radius Turning

the cutting tool is set central with the work, the bottom slide adjusted by cross-movement to the desired radial position, and the set-screw on top of block *F* tightened. The cross-traverse screw in the bottom slide is, of course, removed to permit a free radial movement of the tool-slide. The tool is fed in by means of a screw and nut on the top slide. The distance from the center of clamp *F* to the center of stud *H* must be equal to the radius to be machined.

E. STRETTAS

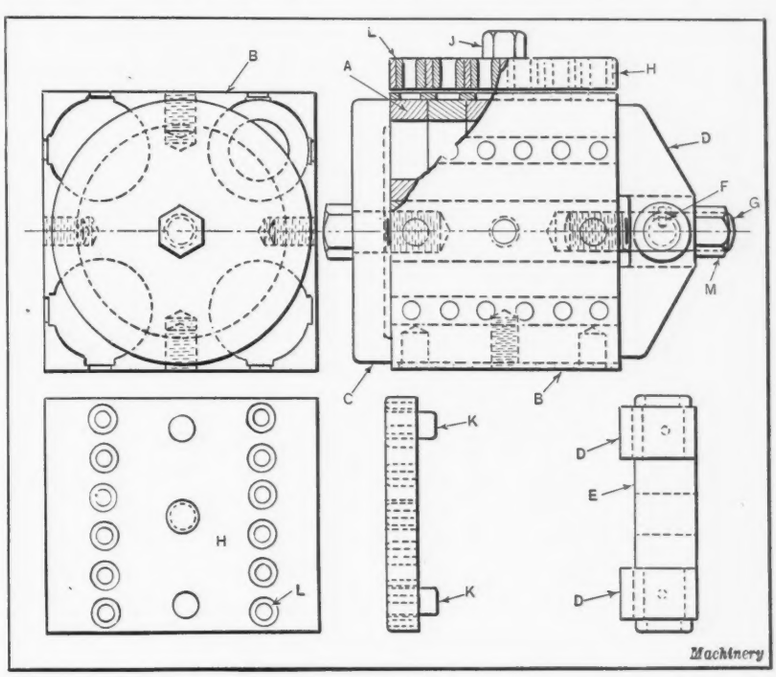
JIG FOR DRILLING AND TAPPING SHAFT COLLARS

The jig here illustrated was designed to facilitate the rapid drilling and tapping of shaft collars to receive two set-screws located 90 degrees apart. The fixture holds twenty-four collars, which are locked securely in position by tightening one nut. One of the collars is shown in the broken section view at *A*. The body *B* of the jig has four holes bored through it lengthwise to hold the collars. The circular piece of metal *C* bolted to one end of the jig serves as a stop. The equalizing clamp on the opposite end consists of two clamps *D* which are bored out to receive the turned ends of the cross-piece *E*. Pins *F*, which fit loosely in keyways cut in the turned ends of piece *E*, allow the clamps to have a slight rocking motion, but prevent them from getting out of place. Piece *E* is drilled in the center to receive stud *G*.

The bushing plate *H* is made from a flat piece of iron, drilled in the center to receive a cap-screw *J*, which locks it to the main body of the jig. Two dowel-pins *K* serve to locate it in place. The drill bushings, one of which is shown at *L*, are made of hardened steel. The jig body is drilled on all four sides to receive the bushing plate. The holes in the jig body which contain the collars are relieved directly under each row of bushings, so that any burr raised in tapping will not interfere with the removal of the work.

When the jig is in use, the four holes are filled with collars, and the clamps *D* put in position and locked or tightened by means of the nut *M*. The loaded jig is placed between two parallels secured to the drill press table, after which the bushing plate is put in position and the holes are drilled on one side of the two rows of collars. The drilling operation is repeated on the three remaining sides of the fixture, transferring the bushing plate each time.

Battle Creek, Mich. BRUCE DEVEREAUX



Drill Jig for drilling and tapping Shaft Collars

KNURLING OR FLUTING DIE

The redraw method of forcing a shell through a straight grooved die is often employed in the manufacture of sheet-metal cylindrical parts which require a straight knurl or fluting on the outside. The die is usually made like a redraw die, enough metal being left on the inside to permit broaching a series of fine grooves in the walls of the opening. A redraw punch is used to force the shell through the die in order to form the flutes on the outside of the shell. In making straight dies for fluting operations, considerable trouble is experienced due to shrinkage of the die when hardening.

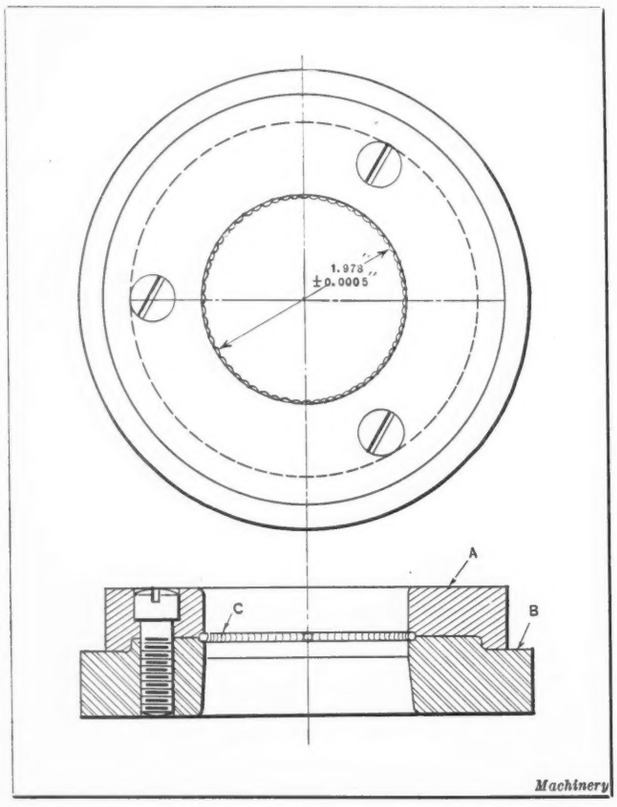
The writer, who has had considerable experience in this line of work, has yet to find a case in which the shrinkage or change in structure of the steel resulting from hardening was the same in two dies made as nearly alike as possible. Regardless of how close the shrinkage allowances are calculated, there is always some variation in the hardened dies, which necessitates stoning them to size. This method of bringing the dies to size is expensive and must be done by a skilled workman.

The die after heat-treating, especially if there are many sharp teeth, is quite likely to come out of the fire in a semi-hard condition. The edges may be burned so that the die either will not stand up well or will load up, thus necessitating disassembling and restoning. Should the die fail to shrink the amount calculated, another heat-treatment may be necessary, and if this is not satisfactory another die must be made.

In the accompanying illustration is shown a straight knurling die which the writer designed after considerable trouble had been experienced with the solid type of die. Hardened steel balls *C* such as are used in bearings serve as the flute forming means of the die, which is of very simple construction. The top and bottom ball retainers *A* and *B* are made of a good grade of tool steel, and are hardened and ground. The grooves are stoned and lapped to size. One set of retainers made in this manner was used for fluting 250,000 pieces. The hardened steel balls *C* were of a

good grade, such as is used in the regular product of a ball bearing manufacturer. A number of different makes were tried out until one was found that suited the particular requirements. The balls are so fitted in the retaining groove that they can be revolved with the fingers. In assembling the two retainers, a small amount of grease is used to hold the balls in place while the retainers are being fastened together.

The die illustrated was used in fluting a cap made from 0.093-inch hot-rolled steel having an outside diameter of 2 inches and a length of 7/8 inch. Except for the occasional breaking of one of the balls, which caused no damage to the retainer, practically no trouble was experienced. A die of the same type has also been used successfully in fluting a shell 1 7/8 inches in diameter by 4 7/8 inches long, made from 0.065-inch hot-rolled steel. This shell was knurled for a distance of 3 inches and then backed up or returned through the top of the die. The balls used for this die were broken more often, and wore down so that the surface be-



Die in which Hardened Steel Balls are used to knurl Drawn Shells

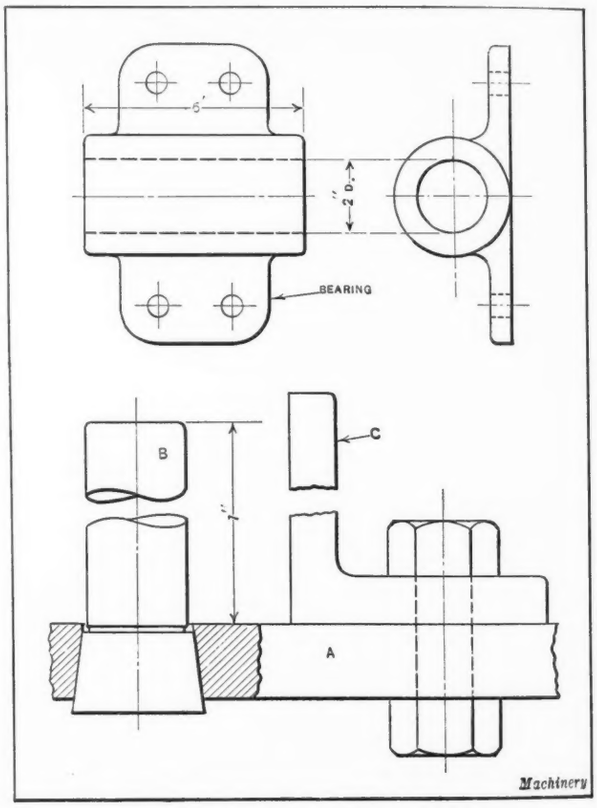
came somewhat rough, but this was to be expected, as a fast drawing speed was employed. Small shells 1/4 inch high, having an outside diameter of 1 inch and made from 0.018-inch cold-rolled steel, have also been knurled or fluted successfully with the type of die described, using steel balls 0.062 inch in diameter. G. M. B.

BABBITTING FIXTURE FOR SMALL BEARINGS

An arbor press may seem out of place in a babbitting shop, but when small and medium sized bearings are being handled, it can be of real service. Three hundred hand-truck axle bearings, like the one shown in the upper view of the illustration, were to be babbitted to give a clearance over the axle of about 1/64 inch without machining. Instead of making an expensive babbitting jig, the following simple device was used:

A tapered hole was reamed in the thick baseplate *A*, shown in the lower view of the illustration. A steel mandrel *B*, which was to act as a core for the babbitt, was fitted in this hole and wedged into place by being driven up from below. At a proper distance from the hole an angle-plate *C* was bolted to plate *A*, and the whole assembly mounted on the table of a small arbor press, with the mandrel centered below the ram of the press. The upper part of the mandrel was made with a taper of about 0.003 inch in 7 inches, so that it could be drawn from the completed bearing.

In operation, a bearing casting—previously warmed—was set over the mandrel and clamped against the angle-plate by means of two small hand-clamps. A ring of clay was worked around the bottom of the bearing where it rested on the baseplate, and another ring of clay placed on the upper end to guide the flow of metal. The babbitt, poured by hand, hardened in a few seconds; the clay was then broken away, the mandrel pressed out by the arbor press, and the completed bearing unclamped and removed. The whole process, from the first driving up of the mandrel to the removal of the completed bearing, required only a few minutes. By this method, the operator and a helper produced thirty bab-



Bearing, and Fixture in which it is held for babbitting

bitted bearings in five hours. The mandrel, warmed by a blow-torch for the first bearing, was kept hot enough by each pour of babbitt for each succeeding bearing.

This method is useful in the small shop where jobs of this nature come in too seldom to warrant the purchase of special equipment. The mandrel is the only item that must be made, as the other fittings can be picked up around the shop. While the particular bearing described was rough and did not require machining, the same procedure is applicable to any job where the babbitt is not to be poured under pressure. By making the mandrel a little smaller than the journal for which the bearing is intended, the bearing can be reamed out in the usual way.

Pensacola, Fla. FRANCIS M. WESTON

* * *

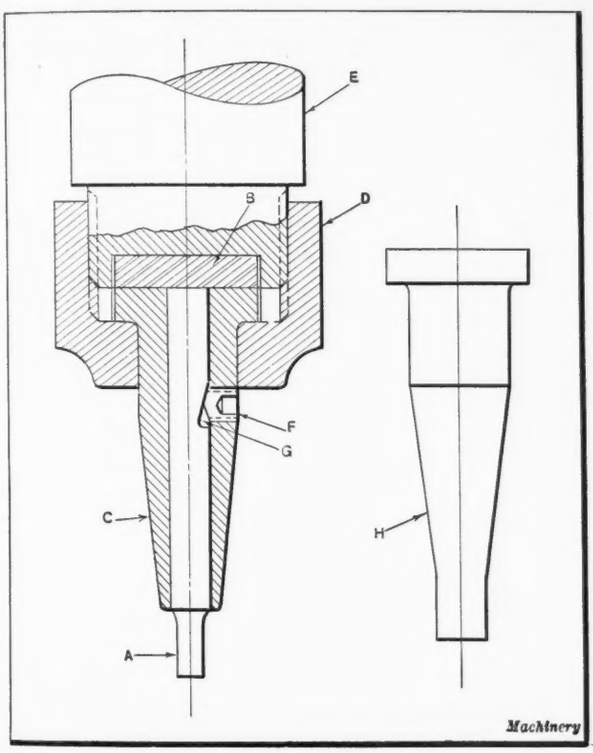
The American Engineering Standards Committee, which is in constant communication with the national standardizing bodies in nineteen industrial countries of the world, reports that in Germany there have already been approved nearly one thousand industrial standards. Of these, 60 per cent represent standards dealing with the machine industry.

Shop and Drafting-room Kinks

HOLDER FOR PIERCING PUNCH

Punch-holders constructed as shown in the accompanying illustration have proved very satisfactory for piercing operations on punch presses. When this type of holder is used, the punch can be easily and quickly replaced. The small type of punch shown at *A* is made from unmachined hardened and drawn carbon tool steel or high-speed steel. The small disk *B* above the punch is made from the same material as the punch, and is also hardened. The other parts of the holder are soft steel, the adapter *C* being drilled and reamed to receive the punch *A*.

The retaining nut *D* is made from hexagonal stock, and is threaded to fit the shank *E* of the holder. The safety



Punch-holder for Use in performing Piercing Operations on Punch Presses

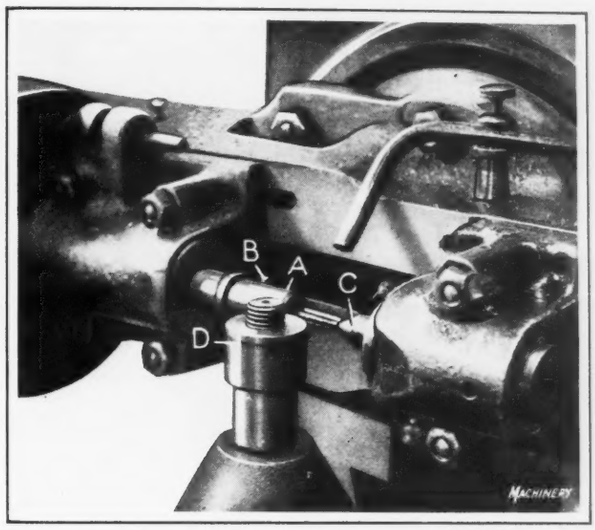
set-screw *F* serves to hold the punch in place in the adapter *C*. A small notch, as shown at *G*, is ground on the side of the punch *A* to form a seat for set-screw *F*. For punching larger holes, adapter *C* is removed, and punches *H* employed.

Lima, Ohio — ROGER ENGLISH

HOBBING WORM-WHEEL WITH A TAP

In making optical apparatus for inspection work, it was necessary to cut a relatively fine worm-wheel having the equivalent of 16 teeth per inch on the periphery so that a 3/8-inch worm of the same lead might be used. This was accomplished successfully without any expense for special cutters by using a standard 3/8-inch tap as a hob on a Gould & Eberhardt hobbing machine.

A special holder *A* was fitted to the cutter-spindle of the machine. This holder was bored out to receive the shank of the tap, and provided with two set-screws, one of which is shown at *B*. The set-screws were tightened against opposite sides of the square end of the tap, and thus served as the driving means. The other end of the tap was supported by a center *C*, also made for the purpose. The blank



Hobbing Small Worm-wheel with a Tap

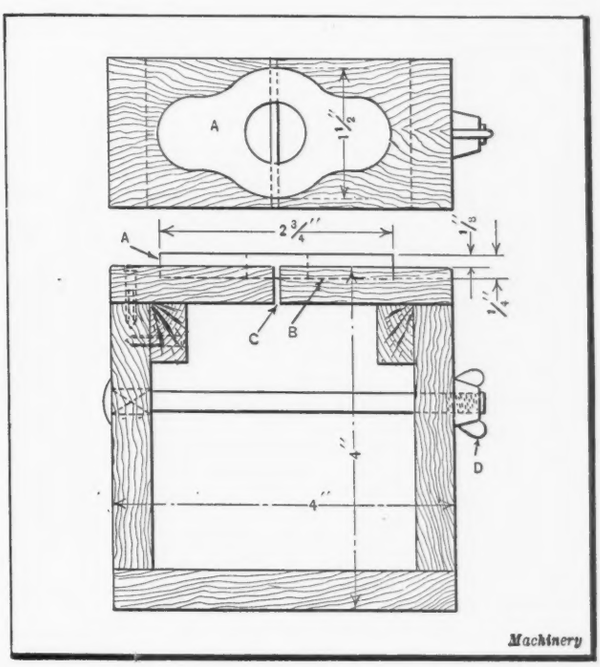
D in which the teeth were cut is about 1 7/8 inches in diameter, and was mounted on the work-holding arbor as shown.

Springfield, Vt. — O. S. MARSHALL

HAND FIXTURE FOR DISK GRINDING

Difficulty is often experienced in disk-grinding thin pieces like the flange shown at *A* in the illustration. The grinding of thin pieces is considered an unpleasant operation, as it brings the fingers close to the grinding wheel. However, this trouble can be remedied in most cases by using a work-holding fixture. The fixture shown in the accompanying illustration for holding part *A* is simply a wooden frame with a recess cut at *B* about ⅛ inch deep, and of the same shape as the flange to be ground. The upper member of the fixture is cut in two at *C*, thus forming two jaws which can be clamped on the work by tightening nut *D*.

Bolton, England — T. H. HAYES



Wooden Hand Fixture for disk-grinding

Questions and Answers

MACHINING STAINLESS STEEL

W. B.—What are considered the best speeds, feeds, and cutting angles for tools used to cut stainless steel in production work on turret lathes?

A.—For cutting stainless steel, tools similar to those used for low-carbon or mild steel and similar feeds and speeds—say 50 to 55 feet per minute—are considered most suitable. Sometimes, however, individual cases will require modifications in this respect. Trouble is sometimes experienced from stainless steel tearing. Some brands of stainless steel can be machined more easily than others. If trouble arises, it is usually best to reduce the feed first, and if this does not overcome the difficulty, the speed should be reduced until suitable results are obtained.

GLUE FOR ATTACHING MICA TO STEEL

R. H. C.—The writer has experienced considerable difficulty in obtaining a cement or glue that will cause sheet mica, approximately 0.010 to 0.015 inch in thickness, to adhere to cold-rolled sheet steel or cast-iron plates. All the common glues, ordinary shellac, and button shellac have been tried without success. Can any of the readers of MACHINERY give the name or composition of a glue or cement that can be used for this purpose?

ANSWERED BY O. J. FINK, THE IDEAL ELECTRIC & MFG. CO., MANSFIELD, OHIO

The following formula for rosin shellac has been used successfully for attaching mica, varnish, cambric, and other insulating materials to sheet steel, cast iron, copper, or brass. It is necessary, however, that the metal be thoroughly clean before the shellac is applied. First, "cut" some shellac with denatured alcohol, using enough shellac to form a heavy thick paste. Next make a solution of pulverized rosin and alcohol. Then heat the shellac, and mix equal parts of the two mixtures, stirring the materials thoroughly. The resulting rosin shellac should be applied cold.

INVENTION OF ELECTRIC LIGHT

W. S. J.—Who invented the electric light? "A" claims that Thomas A. Edison is the inventor, and "B" claims that electric lights had been made prior to the one patented by Mr. Edison.

A.—Sir Humphrey Davey discovered in 1809 that the separation of the charcoal terminals of a powerful battery caused the formation of a brilliant electric arc, producing light that exceeded in intensity all the other known forms of light. This discovery led to the development of methods of feeding one carbon terminal toward another in order to maintain an arc, but for many years such arc lights were confined to the laboratory, since the current could only be obtained at that time from batteries. Very efficient electric lamps, however, used in conjunction with batteries, were devised by Foucault, Duboscq, Deleuil, and others, as early as 1853. The real development, however, of the electric light began with the invention of the dynamo. Among those who made notable contributions to arc light development should be mentioned Brush, Weston, Thomson, and Houston.

Although Thomas A. Edison is credited with the invention of the incandescent light by decision of the courts, as well as popular opinion, the first incandescent light is said to have been devised in 1840 by William R. Grove, inventor of the Grove battery. In 1845 an incandescent lamp was patented in England by August King, who acted as an agent for a Mr. Starr, an American inventor. This lamp was known as the Starr-King lamp. William E. Sawyer applied in 1877 for a United States patent for an electric engineering and lighting system. The form of incandescent electric lamp which resembles in its main features the modern type, was patented by Edison in 1880. This lamp had a thin filament of carbon which was sealed in a vacuum so that it would not burn away but remain incandescent. The small carbon filament and its high resistance permitted proper distribution of current to a number of lamps without special regulation. Moreover, the cost of making lamps was low enough to permit discarding them when the filament was finally destroyed as the result of use. The claims of Mr. Edison were contested by William E. Sawyer and his partner Albon Man, which at first resulted in the grant of a patent to Sawyer and Man in 1885. This was followed, however, by patent litigation in the courts which terminated in 1892 in a decision by the United States Court of Appeals awarding the incandescent lamp to Edison.

STEAM ENGINE DEVELOPMENT

C. R. N.—Was James Watt the first man to build a steam engine or did he develop engines constructed by earlier inventors?

A.—The steam engine, like most other great inventions, was the result of an evolutionary development which was due to the work of several inventors. Although the most notable improvements were made by James Watt, considerable pioneer work had been done previously. In 1690 Denis Papin originated the first cylinder and piston type of steam engine, but the scheme was impracticable owing to the fact that both boiler and cylinder were combined in one vessel. Thomas Newcomen, in 1705, made a practical form of piston engine, although it was very crude and inefficient and simply provided a reciprocating motion. About 1711 Newcomen's engine was introduced for mine pumping, and by 1725 it was in common use in collieries and continued in use for about three-quarters of a century. This engine was of the atmospheric type, depending for its action upon condensation of steam and the atmospheric pressure.

In 1763, James Watt, an instrument maker in Glasgow, while repairing a model of Newcomen's engine, perceived the waste of steam resulting from alternate chilling and heating of the cylinder. The result was the origin of the condensing apparatus, involving the use of a separate condenser, cooling water, and an air pump for maintaining a partial vacuum. Although this was a notable improvement, the engine was still suitable only for pumping, as it was a single-acting type with steam admitted during the entire stroke. Motion was transmitted from the piston to the pump rod through an oscillating "walking beam," but there was no rotary motion. In a second patent, issued in 1781, the sun and planet wheels and other methods of securing a continuous rotary motion are described. Watt had invented the crank and connecting-rod for this purpose, but meanwhile it had been patented by Pickard; hence, the sun and planet motion was used by Watt until the patent on the crank expired. In 1782, Watt patented two additional improvements of great importance. One was the double-action principle, whereby pressure is applied alternately to each side of the piston, and the other was in using steam expansively by stopping its admission when the piston had made only part of its stroke. Henry Maudslay made further improvements in the steam engine by eliminating the cumbersome wooden walking beam of the Newcomen and Watt engines, and connecting the cross-head and crank direct.

Centerless Grinding Practice*

By W. J. PEETS, Engineer in Charge of Factory Methods, Singer Mfg. Co., Elizabethport, N. J.

THE centerless grinder has come to play an important part in the quantity production of cylindrical ground work. It consists primarily of two abrasive wheels mounted so that their peripheries face each other, one of the wheels having its axis so arranged that it can be swung out of parallel with the axis of the other wheel by varying amounts, as required. Between these two abrasive wheels is a rest which supports the work. (Fig. 2.) The two wheels are run at different speeds, the fast-running or grinding wheel at regular grinding speed, say, 5500 to 6000 feet per minute at the periphery, and the slow-running or regulating wheel at the work speed only, which latter varies according to the material, length, diameter, etc., of the work being ground. The wheels are revolved so that their adjacent faces move in opposite directions; therefore a piece of cylindrical work placed on the rest between the wheels and touching both of them will be revolved by contact with their two surfaces. The wheels are revolved at different peripheral speeds because, if both ran at one speed, the work placed between them would be merely revolved as an idler gear, with no grinding action. The difference in surface speed of the two wheels imparts the necessary relative motion for grinding.

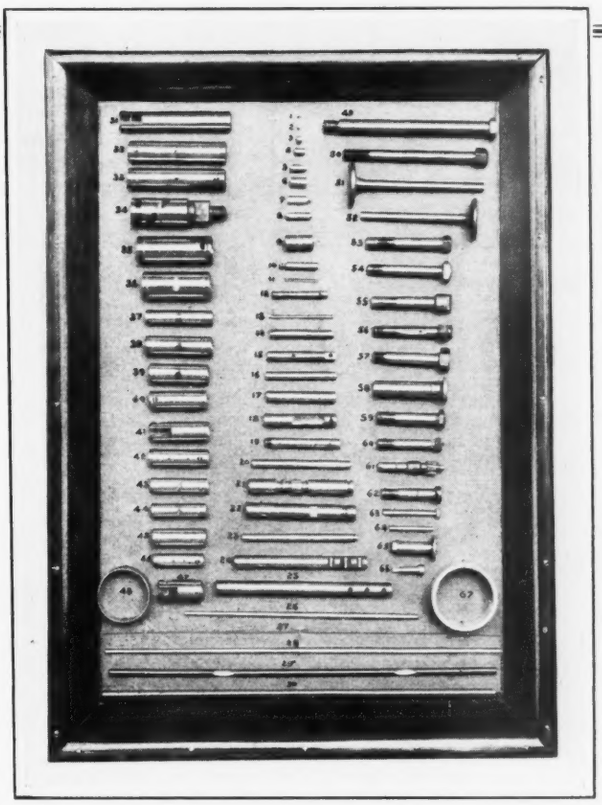


Fig. 1. Examples of Parts ground on Centerless Grinding Machines

The success of centerless grinding lies fundamentally in the fact that the friction of rest is greater than that of motion. For this reason, the work between the two wheels will take the same peripheral speed as the slower-running, or regulating, wheel, as if geared to it. Thus the cylinder to be ground revolves between two abrasive wheels of different surface speeds, but turning as if geared to the slower of the two, and being held against the work-rest by the pressure of the grinding wheel.

Now, if the axes of the two wheels remain parallel, the cylinder placed between them will receive no motion except that of rotation. However, if the axis of one wheel is thrown out of parallel with that of the other, as well as out of line with the work-rest, a lengthwise motion will be imparted to the work, causing it to travel forward past the wheel surfaces by a certain amount per revolution of the regulating wheel, according to the adjustment given that wheel for this purpose. Thus the speed of passage of the work through the machine is governed by changing the angle between the axes of the two wheels.

Therefore, according to the relative axial position of the wheels, the centerless grinder may be employed for two distinct classes of cylindrical grinding. (1) By setting the axis of the regulating wheel parallel to that of the grinding wheel and feeding the regulating wheel straight in toward the grinding wheel, the work may be ground without lengthwise travel. This affords wide application of centerless grinding to all sorts of shouldered work, such as studs, etc., having two or more diameters, and is known as "straight-in grinding." (2) By setting the axis of the regulating wheel at an angle to the axis of the grinding wheel, the work is kept in constant lengthwise motion through the machine, this being known as "through-grinding." In this latter case there is no forward movement of the regulating wheel, except as it must be advanced by the operator from time to time to compensate for wheel wear, or its distance from the grinding wheel changed to suit different sizes of work. Each of these two kinds of grinding will be described.

Advantages of Centerless Grinding

The chief advantage of centerless grinding is that the action (in through-grinding) is continuous. On work of small or medium diameter and length, the operator is kept very busy simply feeding the machine.

A much smaller stock allowance for grinding is necessary than in between-centers grinding due to all errors in centering being eliminated and to the fact that only enough stock need be removed to take away the tool marks. While it is necessary to remove from 0.006 to 0.015 inch when grinding between centers, as little as 0.00075 inch is sometimes sufficient in centerless grinding.

The work is as a rule better supported in centerless grinding. This is especially true of pieces that are long in proportion to their diameter.

The size of work can be held to closer limits on the centerless grinder with less skill on the operator's part, as the wheels are not moved during grinding, and the chances of errors arising from infeed of slides, stops, etc., are eliminated. Also, in centerless grinding, stock is removed from the diameter instead of from the radius of the work, which reduces by one-half any error due to wheel wear (as compared to between-centers grinding).

This simpler type of machine, besides requiring a less skilled operator, also effects a considerable reduction in upkeep expense, as the only moving parts, while operating, are the two wheel spindles.

No centering is required.

Limitations of Centerless Grinding

The main limitation of the centerless grinder is that quantities of work must be fairly large to warrant setting up the machine.

*Abstract of paper to be read before the Machine Shop Practice Division of the American Society of Mechanical Engineers at the meeting held in connection with the New Haven Machine Tool Exhibition at New Haven, Conn., September 8-11.

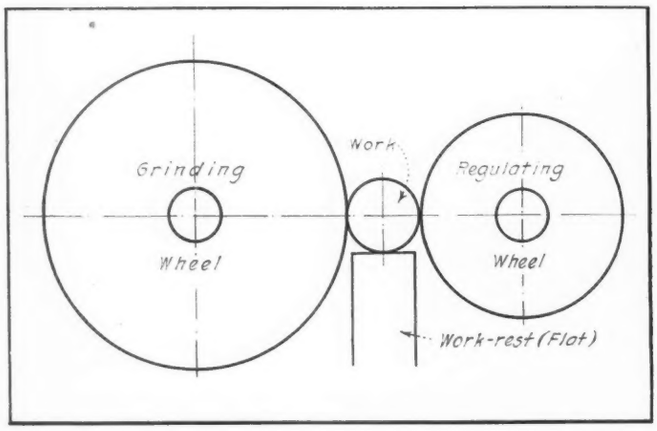


Fig. 2. Principle of the Centerless Grinding Method

The type of work is limited to pieces of one diameter for through-grinding, and of one or two diameters for shoulder work in straight-in grinding.

The centerless grinder cannot hold the outside of a bushing concentric with the hole, and for best results, flats and keyways or oil channels (especially those running to the end of the piece) should be avoided.

Exact roundness such as is required for gages, etc., is harder to obtain than on the best types of between-centers grinders. By this is meant uniform roundness well within a tenth of a thousandth of an inch.

Thus the field of usefulness of the centerless grinder may seem somewhat restricted, but there is an ever-growing variety of work that can be ground by this method, or that can be designed so as to be so ground. We may say that this type of machine is preeminently suited to straight cylindrical work of one diameter, with no exact reference to bore, and with no prolonged breaks in the surface.

Amount Left for Grinding

Practice in producing straight centerless-ground work varies considerably. In some shops considerable metal is left on for grinding—in some cases as much as 0.016 to 0.020 inch, and even 1/32 inch. Where so much is allowed for grinding, more passes through the machine, and at a slower speed, are necessary. This means greater labor cost, as well as greater wheel wear and cost. As a rule, as little stock as possible should be left for removal by centerless grinding.

In many cases the limiting speed factor is the ability of the operator to feed the machine, rather than the capacity of the machine itself. The peripheral speed and the grade of wheels used are the same as for the same work on any other grinder. However, by leaving a minimum of stock to be removed, a finer-grain wheel may be used and a finer finish obtained. For through-grinding, however, the grinding wheel should be soft enough to dress itself, or wear down by contact with the work, and not glaze or load up. When a wheel is soft enough to dress itself in this way, frequent diamond dressing is unnecessary, and it may be necessary to dress only once in several weeks by passing an emery stick across the wheel face to remove small particles of metal. For this reason, wheels made with a rubber or an elastic bond are often successfully used.

Wheel-dressing for Through-grinding

For through-ground work the dressing of the regulating wheel is really more important than that of the grinding wheel. As the axis of the regulating wheel lies at an angle to the work, it is necessary that the dressing of this wheel should occur at the same angle. One way of accomplishing this would be to remove the work-rest from the machine and put in its place a dressing slide moving in the same plane and carrying the diamond at the same height in relation to the wheel center as the point of contact between the work and the regulating wheel. When the diamond traverses the wheel in this position, the result will be a perfect contact of the regulating wheel with the work during grinding—which is the requirement. Again, the dressing slide for the regulating wheel may be mounted at some other point around its periphery, and correct results may be obtained by swiveling this slide to the same angle to which the wheel is swiveled, and moving the slide or diamond tangentially above or below the wheel center to correspond to the line of contact of the work with the wheel.

The grinding wheel is dressed parallel to the regulating wheel by means of a suitable slide. However, as soon as work is introduced between the wheels, the grinding wheel gradually dresses itself away at the entering side until cutting takes place all across its face, the final sizing being accomplished as the work leaves the wheels. Thus it will be seen that the original parallel dressing of the grinding wheel is lost after a few pieces have passed through and that instead of the faces of the two wheels remaining parallel, they are out of parallel by the amount of stock which is removed during one pass through. Here will be seen a further necessity that the grinding wheel be soft enough to dress itself by contact with the work passing through. The regulating wheel has practically no grinding action and therefore does not wear away as the work is rolled upon its surface. It is common practice to have the regulating wheel somewhat harder than the grinding wheel.

Work Guides

It is necessary in through-grinding to have guides of some sort to start the work in line with the wheels, and to guide it as it leaves them. These guides are usually parallel strips of hardened steel, adjustably mounted so as to form side boards along that part of the work-rest that projects beyond the wheels. Facility of adjustment is an important factor in setting these guide plates, and some experience is necessary to do it properly. Generally speaking, the guides should extend at the front and back of the machine to a distance equal to the length of the work being ground, as they are particularly necessary on long work of small diameter, that has a tendency to whip, if not properly supported. It is not always possible to extend the guide plates this far from the machine, especially when grinding shafting, drill rod, etc.; external guides are usually provided for such long pieces.

When setting the guide plates, care must be taken not to cramp the work as it enters or leaves the wheels, as this will result in tapered work; on the other hand, guide plates too loosely set may cause chatter on long work. Sometimes a desired taper is produced by purposely setting the guide plates so as to cramp the work as it leaves the wheels. This method is not recommended for great accuracy.

Can Round Work Be Produced By the Centerless Grinder?

A common question regarding centerless grinders is, "Can round work be produced from stock which is originally not

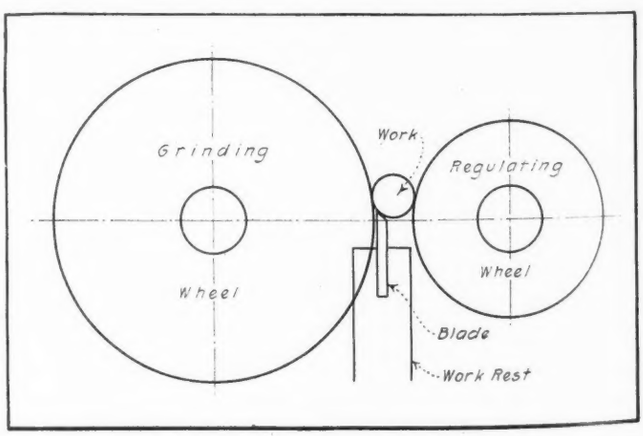


Fig. 3. Arrangement for grinding Out-of-round Work True

round?" This is a reasonable question for two reasons. First, the work while being ground is not held on any center but is free between the wheels. Secondly, out-of-round work will be produced by centerless grinders under certain conditions. Experience with such out-of-round work has led many persons to state that the centerless grinder is only a sizing machine and that it cannot generate round work. The fact that out-of-round work may be produced on this machine under certain conditions makes it wise to have some means for testing roundness other than a snap gage or micrometer. A good method is to use a V-block, over which is mounted a dial gage or other registering instrument. A piece of work revolved in a gaging device of this kind readily registers any out-of-roundness which may be present. With the proper setting, round work can readily be produced by the centerless grinder. By this is meant roundness registering to a limit one-tenth of a thousandth inch in the V-block test.

For a machine to round up work originally out-of-round, the most important thing to consider is the relation of the center of the work to the centers of the two wheels. If a piece of work elliptical in shape, or having flats in its diameter, is placed in the machine so that its center is directly in line with the centers of the two wheels while resting on a flat work-rest, an out-of-round product will result. The out-of-round piece will usually tend toward a three-cornered shape. It will gage correctly for size at any point all around, but if given the V-block test it will be found to be far from a true cylinder.

Influence of Setting of Work-rest

In general, the reason for this is that, as the regulating wheel is directly opposite the grinding wheel, a depression at any one point in the work's surface will produce a high point on the side of the work directly opposite—the approximate center of the piece simply moving back and forth across the flat work-rest. (Fig. 2.) Once this three-cornered condition is established, further passes through the machine will do little or nothing to remove it.

Now, if the work is elevated so that its center is somewhat above the center line of the wheels and a 45-degree angle-rest is substituted for the flat one (Fig. 3), a condition is reached that tends to round up the work, even though it is presented to the machine in an out-of-round form. This is partly due to the fact that as the work is now above the center line of the wheels, the points of contact of the wheels upon its surface are not directly opposite each other as regards the center of the work, so that a high point on the work will not now produce a low point directly opposite. Also, the contact of this style of work-rest with the work is very near the grinding wheel, and not directly below the work. Here again, probably no mathematical analysis has been evolved to explain the action that takes place. However, the fact remains that commercial cold-drawn or even hot-rolled steel, by proper care in setting up and by sufficient passes through the grinder, will be finished round within the aforementioned limit of 0.0001 inch as well as accurate to size within about 0.0002 inch, or perhaps closer. Therefore it is evident that the setting of the work-rest is a very important matter when accurate work is necessary.

Work-rests are subject to considerable wear, and are usually made of hardened steel or stellite. The latter material has been found superior. It is usually brazed into a steel plate and ground to shape. The condition of the cooling compound used is also a factor in the wear of the work-rest, and the cleaner this compound is kept, the less wear will take place.

Production by the Through-grinding Method

The rate of production of work by the through-grinding method will vary greatly, according to the material and diameter of the work, the amount of stock to be removed, and the accuracy of finish wanted. Where the work is comparatively large and long, the output depends entirely upon the capacity of the grinding wheel and the power of the machine, while on short pieces of small diameter, where little stock has been left for grinding, the capacity of the machine may exceed the ability of the operator to load it.

To quote from actual experience, hardened shafts 1/4 to 3/8 inch in diameter and from 4 to 16 inches long may be ground round, within limits of 0.0005 inch in diameter—removing from 0.00075 to 0.001 inch in one pass through the machine, at the rate of 12 to 15 feet per minute—using a 100-grain elastic-bond wheel and producing a fine commercial finish. These same shafts may then be reground to a total limit of two-tenths of a thousandth ($\pm$ 0.0001 inch) by giving them an additional pass through the machine at the same rate. Where coarser wheels are used, this production can doubtless be increased. Even at the rate of 15 feet per minute, forty-five 4-inch shafts are produced per minute (2700 per hour) receiving one pass through the grinder.

Many cylindrical parts having burrs thrown up by cutting-off, cross-drilling, or milling may be very economically burred by passing them through the centerless grinder, although they may not need grinding. It often pays to redesign certain parts so that they can be finished on the centerless grinder.

Where work is required to be concentric with a hole through it or with a smaller diameter, it is often the custom to rough-grind it between centers to a wide limit, and then finish-grind it in the centerless-type machine, thus securing the accurate finish of the latter at a combined cost which is often less than that of finishing the work between centers.

Straight-in or Form Grinding

This class of work is possibly more interesting than through-grinding because of its almost endless variety. The regulating wheel, as previously mentioned, is set at zero, or as nearly so as possible, and the outside plates for guiding the work to and from the wheels are removed, only the work-rest between the wheels remaining. The action is usually as follows:

The regulating wheel is sufficiently withdrawn from the grinding wheel to permit the work to be placed between the wheels, either manually or by suitable mechanical means. In this position, the work is supported by the work-rest and regulating wheel, but does not touch the grinding wheel. The regulating wheel is then advanced, revolving the work upon the inclined surface of the work-rest until contact is made with the grinding wheel, after which the grinding is done by means of further forward movement of the regulating wheel. After grinding, the regulating wheel is withdrawn and the work ejected or allowed to roll down between the work-rest and regulating wheel and thus out.

Where large quantities of work are to be handled, hoppers and magazines are specially built for the purpose. Small work with a minimum of stock to be removed is thus ground in as little as three seconds per piece, including loading.

As wheels 8 inches wide and possibly wider are being used, and as dressing slides are being developed capable of producing tapers, forms, and radii, an almost endless variety of work is possible.

Roundness, size, finish, etc., are affected by the same elements in straight-in form grinding as in through-grinding, although the action is somewhat simpler due to the regulating wheel not being set at an angle. The angle of the work-rest and the position of the work above the center line of the wheels are important in obtaining roundness on straight-in ground work for the same reasons as those applying to through-ground work.

In conclusion, it may be said that, as in the case of between-centers grinding, a great deal depends upon spindle construction and maintenance. If close limits are to be held (say, 0.0001 or 0.0002 inch), both the grinding-wheel and regulating-wheel spindles must be run very close to their respective boxes, as a small displacement of either will result in loss of size and tapered work. This is particularly true of through-ground work, where full contact between the work and the wheels is not constant, as when single pieces are entering or leaving the wheels.

Precise Cylindrical Lapping*

By PAUL M. MUELLER, Engineer, Pratt & Whitney Co., Hartford, Conn.

THE production of precise cylindrical surfaces has always occupied the attention of engineers and mechanics. With the introduction of the cylindrical grinder came a precise and easy control, and quantity production to fine limits was made possible. However, the solution of the problem of making fine commercial cylinders created the problem of making still finer cylinders for gaging that production. In a great many cases, these gaging surfaces must be better than can be produced by simple grinding, and the familiar hand-lapping method is used successfully.

The manual method produces nice surfaces of a high finish, when carefully applied, but it has two drawbacks in that it requires skilled workmanship and considerable time. In other words, it is expensive. Furthermore, each unit of a lot of gages must be treated separately until finished. The operator cannot set the lap, go through a batch of gages and, without intermediate test, be sure that they will all be identical. From a gagemaker's viewpoint these drawbacks are very annoying. The gagemaker wants to make a batch of gages, then inspect them and have them pass. Hand lapping and desirable routine are therefore in opposition.

For some time the Pratt & Whitney Co. has been successfully lapping flat surfaces by the Hoke method. (Editor's Note.—This method was described in an article "How Precision Gage-blocks Are Made" in April, 1920, MACHINERY.) In this method there are stationary emery-charged laps between which the gages are pushed by a cranked spider. The top lap floats and is constrained only against rotation. As the work progresses, eventually all blocks will be in uniform contact with each lap. If the laps are parallel, each block is identical with every other block. To insure this parallelism, a transposition is occasionally made in such a fashion that the sum of the lengths of any two adjacent blocks is equal to the sum of the lengths of any other adjacent pair. Several transpositions are sufficient to remove all grinding errors, and a transposition each time the machine is stopped for measuring, maintains the identity of size. The machine stops automatically after a predetermined number of revolutions, and the operator sets the revolution dial to remove half of the remaining plus metal.

It was obvious that some similar form of lapping for cylindrical work would have the best chance of success. Several trial set-ups of apparatus were made and one of them worked nicely; in fact, results were beyond expectation, for better surfaces were produced than could be made by hand lapping, and size control was so simple that the gage diameters could be kept just under the maximum value of the wear limit.

*Abstract of a paper to be read at the meeting of the Machine Shop Practice Division of the American Society of Mechanical Engineers in New Haven, Conn., September 10, 1925.

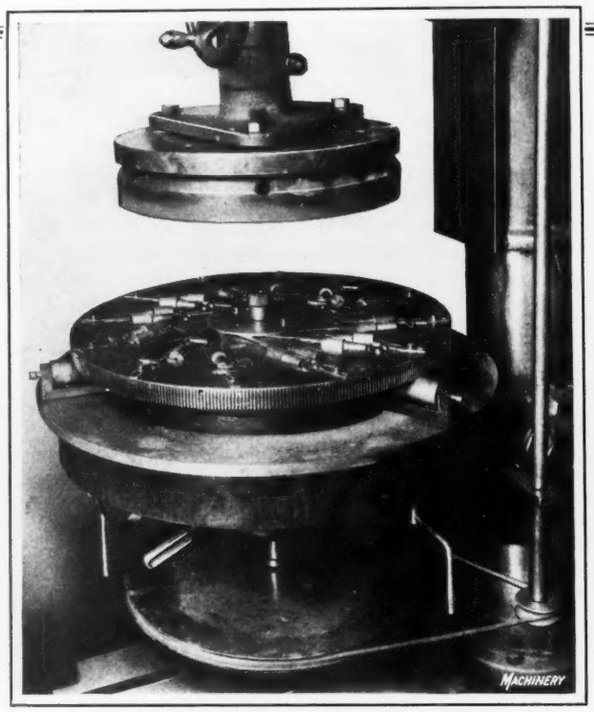


Fig. 1. Machine used for lapping Cylindrical Gages

Method of Production

The first trials were made in the Hoke machine with both laps stationary as for flat work and with the cylinders in a slotted spider between the laps. The spider was given a cycloidal movement as shown in Fig. 2, so that a given cylinder went through the following phases in a half-cycle of the cranks: (a) Pure sliding on diametral elements; (b) combined sliding and rolling; (c) pure rolling; (d) combined sliding and rolling; (e) pure sliding, and so on. The sliding was to effect the reduction, and the rolling to distribute the reduction uniformly. The theory was good but the work came out staved like a barrel. All the pieces were identical, however, and the remedy for the staving in sight.

Fig. 1 shows the apparatus that solved the problem nicely. The upper lap rotates in this case, but otherwise floats and aligns itself on the cylinders in the spider between the laps. The bottom lap is stationary as before. Thus, in effect, the assembly is a roller thrust bearing. It differs from a thrust bearing in that the cylinders are set at an angle to the spider radius and the spider is off center with the laps. The spider is free to rotate around a crankpin, and the crankshaft is slowly and positively driven from the upper lap spindle. The eccentricity of the crank is used to distribute the wear on the laps. Those who have used a planimeter know the action of the metering wheel with its combined sliding and rolling. Its analogy to the rolls in the spider is exact.

This last-mentioned method produces cylinders with high finish that are diametrically identical, parallel, and with straight elements. The precision is almost mathematical, but the work is not cylindrical. The cross-section is bounded by a peculiar lobed curve, always having an odd number of lobes. The removal of these lobes will be discussed more fully later.

Rough- and finish-lapping operations are done on the same laps and equipment. The only distinction is that during roughing, free emery and kerosene are applied, and during finishing, cream rouge and kerosene are used with no free abrasive. The roughing emery is usually SF 10X Washington Mills. This is a floated emery whose grain size is easily resolved under a microscope with a magnifying power of 25.

Preparation Before Lapping

In general, work is prepared for lapping by grinding. For gage work we find it most economical when the grinding size is 0.0002 to 0.0003 inch above the finished size. When the quantity is sufficient, cylinders 1/2 inch in diameter and smaller are lapped from the hardening fire without intermediate grinding. Three-sixteenths to one-half inch stock is rolled down a plane into the quench to keep it as straight as possible. Smaller diameters are hardened in the

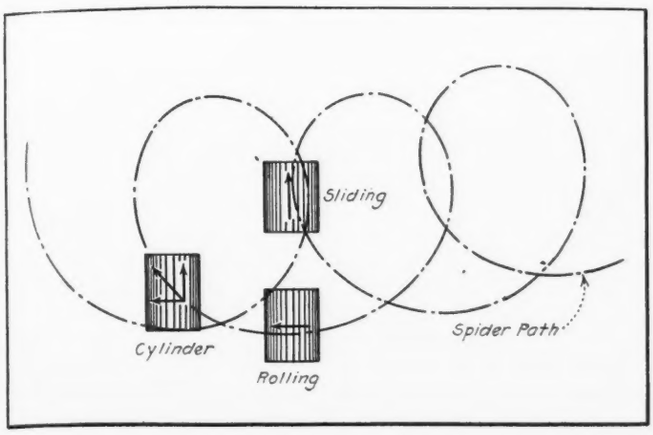


Fig. 2. Path of the Rollers on the Laps when using the Hoke Lapping Machine

bar, broken up, and the ends of the short pieces smoothed preparatory to lapping.

When extremely hard surfaces are required, finish-ground cylinders are quenched from a cyanide bath. The thin scale formed is removed under the laps and the cylinders finished to size without intermediate grinding.

Preparation of Laps

To get the best work, the laps must be as flat as it is possible to make them. However, this is not difficult to accomplish. They are divided into groups of three or four, and separate pairs of a group are rubbed together, with fine emery between them, until they fit in any position. When this condition is reached, the surfaces of that pair are either planes or spheres. After several pairs are fitted, new combinations are made and rubbed until they, too, fit. This procedure is carried on until any pair of laps selected at random will fit. When this has been accomplished, we can say definitely that the surfaces are planes, since, if one lap is the complement of two others, these must also be identical.

A freshly dressed lap looks to be anything but cast iron. After so much rubbing, the emery is driven into the soft metal so uniformly that the surface is like the facet of a jewel. The face presents millions of tiny cutting edges so small that the scratches produced on the work are almost invisible.

It is a remarkable fact that the laps tend to improve with use. As the work slides and rolls about on the faces, the tiny cutting grains are still further reduced in size by crushing, so that eventually they will not cut at all. It is due to this fact that free emery and oil are used while rough-lapping, in order to replace those grains which are continually being destroyed. The finish-lapping is begun when the work is of such diameter that the reduction to finish size will be complete when the emery has just "gone dead." When the emery is "dead," there is a mirror finish on the work.

Removing the Lobes

Discussing in more detail the lobing of work which was mentioned earlier, the simplest case is that of three lobes, as shown in Fig. 3. All of the radii center at the apices of an equilateral triangle, so that the sum of any two radii from an apex is a constant. If parallel measuring anvils are used, the diameter is the same in any position. For this reason, it was some time before it was realized that the lobing existed. If, however, we measure from a V-block the error is apparent at once.

The lobing occurs during the rough-lapping operation. One-inch-diameter rolls usually have from 15 to 33 lobes, and the three-lobed form appears only when the diameter is less than 1/8 inch. The amount of deviation from the true cylinder is usually negligible, but can be felt as a roughness when the sagitta error is only 3 or 4 millionths of an inch. Since the lobed pieces are identical in diameter, the removal of the lobing is easily done by a rapid hand operation with a ring lap. Several passes of the lap to and fro are sufficient to remove the bumps and, due to the identity of size, the lap is adjusted only once for the lot. Once removed, the lobing does not appear spontaneously with further lapping. It returns, but creeps in so slowly that the diameter may be reduced as much as 0.0002 inch without introducing a measurable amount.

Measuring with a Millionth Comparator

To manufacture rolls in quantity to such precise limits as may be held with this method of lapping, we require refinements in measuring equipment that the standard measuring machine cannot give us. To this end the Pratt & Whitney Co. has developed two new machines which have proved entirely satisfactory in practice. (Editor's Note.—These machines are a millionth comparator and an interferometer which were described in an article "Comparator for Checking Precision Gage-blocks" in May, 1922, MACHINERY.)

The millionth comparator is used as a transfer medium between the product and a master replica. It consists of a pair of parallel surfaces between which the comparison of a master size and a commercial replica is made. One of these anvil surfaces is movable axially, so that contact can be made with the measurement, and the axial displacement of the anvil can be read on an optical scale at a magnification of 20,000 to 1. This scale is comparatively coarse (about 0.020 inch movement of the scale being equivalent to a one-millionth of an inch displacement of the anvil), so that measurements may be transferred from the master to the replica with less than two ten-millionths of an inch.

It has been found impossible to use a master which is not a replica of the work where extremely accurate matching is required. For instance, if we set the machine on a 1-inch Hoke block and measure a 1-inch cylinder, the cylinder will appear small by two or three millionths of an inch, due to distortion of the contact. If we use a replica, however, the contact distortion is the same on the replica as on the work, and no accuracy is lost. These master replicas or primary masters are calibrated on the interferometer. By means of this apparatus we can determine the number of light waves of known wave length (or color) which at a given instant are between two planes coincident with the opposite parallel faces of a gage-block. When this number is known the length of the gage can be calculated. The light beam is therefore analogous to a scale with divisions approximately two hundred-thousandths (0.00002) of an inch apart.

Before a measurement can be taken, the cylinder must be left in a constant-temperature box until it has acquired a steady temperature. Also, considerable time is needed for the various adjustments, readings, and calculations, so that the measurement of a roll would ordinarily require an entire day. This gage is now a master or primary standard and may be used with confidence to calibrate commercial gages in the millionth comparator.

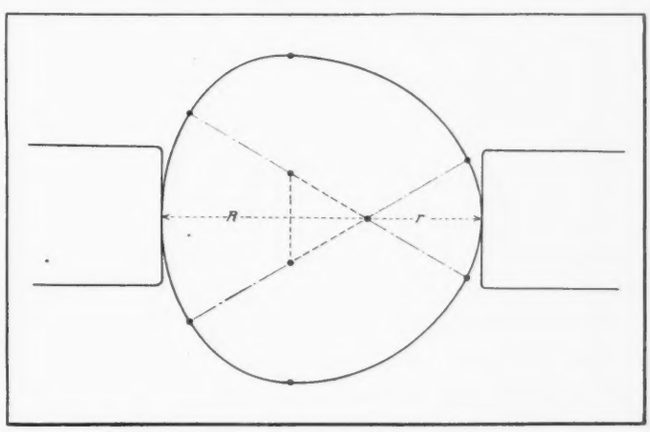


Fig. 3. Diagram showing a Gage with Three Lobes produced in the Lapping

International Tests

A little over a year ago, the Pratt & Whitney Co. decided on a test to determine, if possible, the most probable universal value of the inch. Twenty-four rolls were made up as closely to size as could be determined with the interferometer, and six were sent to England to the National Physical Laboratory, six to the French Bureau, and six to the United States Bureau of Standards for calibration. These rolls were to be intercompared and compared with the standards of these countries and returned, they were then to be shipped a second and a third time until each had been tested by the several bureaus. The test has not been completed so far, but such information as we have shows remarkable agreement, the disagreement being in fractions of a millionth of an inch.

The author measured the rolls several times on the interferometer during the lapping until they were less than a millionth high. When first completed they were so nearly identical that the millionth comparator could not distinguish between them. After about six months in storage they were measured again and were found to have changed less than four tenths of a millionth of an inch.

Summary

To recapitulate, any round piece can be lapped in quantity to a highly finished and accurate surface with speed. Where the conditions demand, extreme precision can be maintained with practical equipment and controls. The apparatus for lapping is not particularly expensive, nor is it difficult to maintain and operate. From the gage-user's viewpoint, the chief value of the method is its inherent ability to cheapen over-all gage cost. Wear metal or "plus" metal on a gage is the greatest factor in determining gage economy. This plus metal is always the algebraic sum of the positive wear allowance and the negative gagemaker's tolerance. Thus the smaller the latter, the greater the economy becomes, provided, of course, that the reduction of tolerance to the gagemaker is not attended by proportionately increased cost.

This lapping method is able to accomplish the desirable result in a practical manner when the quantity of gages of one size is twelve or more, and the economy increases until the number of one size is the number which can be placed at once in two lapping machines under the control of one operator.

* * *

RUST PREVENTION

In an article in *Engineering*, relating to the results of tests made on a number of rust-preventing materials suitable for the protection of stored machinery, C. Jakeman, of the National Physical Laboratory of Great Britain, describes the methods by which tests were conducted on a number of commercial protecting materials. As a result of these tests it may be stated that preservatives of a greasy nature are more satisfactory than hardening paints or varnishes. Lanolin or wool grease is stated to have proved itself to be the best coating. This material can either be brushed directly on the surface to be protected, or it can be deposited from a solution.

GEAR CHUCK PROTECTED BY GARRISON PATENTS

On page 953 of August MACHINERY, a chucking arrangement used in grinding the internal surface of a bull gear was shown in Fig. 5. No mention was made in the article that this type of gear chuck is protected by patents owned by the Garrison Machine Works, Dayton, Ohio. We are informed by O. Garrison, general manager of the Garrison Machine Works, inventor and designer of numerous gear chucking arrangements, as well as of the Garrison gear grinding machine, that the device illustrated in August MACHINERY is covered by Patent No. 1219740 issued to James P. Johnson of Cleveland, Ohio, March 20, 1917, and later purchased by the Garrison Machine Works, the transfer having been recorded in the United States Patent Office.

The unauthorized manufacture of chucks covered by the patent mentioned would be an infringement of this patent. It was pointed out in an editorial entitled "Look Out for Patent Rights" in July, 1924, MACHINERY, that the mere publication of a device in a technical journal does not constitute a right for anyone else to make such a device, if patented, even though no mention is made of a patent in the article.

As stated in the editorial referred to, MACHINERY describes mechanisms in use on machine tools and other kinds of machinery for the purpose of keeping its readers fully informed on current mechanical practice, but the description of a device in a mechanical journal does not imply that it is public property, or that it can be made use of without investigation. A designer can determine when he can legally use a mechanism only by having a search made in the Patent Office, and this should be done before any unusual mechanism is incorporated in a new design, because with the tens of thousands of patents in force, it is not always practicable for a technical journal to specify when the mechanisms and designs it describes are patented, or even always to specify the manufacturer's name.

* * *

Only one woman in the United States has been recognized as an automotive engineer by being accorded full membership in the Society of Automotive Engineers. She is Miss Ethel Bailey of Portland, Me. Miss Bailey is also a member of the American Society for Steel Treating and of the American Society for Testing Materials, and a "fellow" of the American Society for the Advancement of Science. During the war she was stationed at the Nordyke & Marmon Co.'s plant at Indianapolis as assistant to the senior inspector for the Government in connection with the building of Liberty engines. After the war, she was attached to the Bureau of Construction and Repair of the Aircraft Division of the Navy Department. Later she went with the L. W. F. Engineering Co. of College Point, Long Island, N. Y., as engineer in charge of material and parts testing during the building of the Davis-Douglas torpedo planes, bombing planes, and air transports. About three years ago Miss Bailey joined the staff of the Society of Automotive Engineers as engineer in the research department.

PRIZE WINNERS

Five prizes were offered by MACHINERY in the May and June numbers for the best

Tables Suitable for Data Sheets

A great many tables were received in this competition, many of which will be published in coming numbers of MACHINERY. The prize winners and prizes are as follows:

One first prize—Fifty Dollars Cash:

Harry E. Kitchen, Buffalo, N. Y.

Two second prizes—each prize MACHINERY'S Encyclopedia in seven volumes:

Wm. A. and George W. Morgenroth, Harrison, N. J.

A. L. Paschall, Troy, Ohio.

Two third prizes—each prize ten volumes of MACHINERY'S Mechanical Library.

L. P. Vance, Chicago, Ill.

Jacob Young, East Boston, Mass.

The British Metal-working Industries

From MACHINERY's Special Correspondent

London, August 17

THE past month has seen practically no change in the general outlook of the metal-working industry. Conditions are not worse, but unemployment shows no signs of decreasing. Fortunately the coal strike that has been threatening for some weeks past was averted, but the position remains unstable. The trouble arose principally over the demand of the miners for an increased minimum wage, but the mine owners, apparently with some justification, state that the industry cannot afford an increase of this nature. Eventually the Government averted an immediate strike by the promise of a subsidy. Although the general upheaval that must inevitably have followed any general stoppage of work by the miners would, at the present time, have been disastrous, the temporary peace has, it is thought, been dearly bought, and even the immediate outlook is viewed with no little apprehension.

The Machine Tool Industry

The shadow of a coal strike has had the effect of preventing any real revival of business. In the machine tool industry, conditions are very little better than a month ago. Some of the makers of machinery for special work, such as liminated spring plate work, certain types of mechanical and hydraulic presses, and tin box plant equipment, are well occupied, but for the more standard types of machine tools the demand remains inactive and competition is extremely keen. The export business in small lathes shows to better advantage, and makers of boring mills, two- and three-operation automatics, radial drilling machines, and turret lathes are able to keep things moving in their shops, although they are by no means working to capacity. Foreign and colonial railways continue to be good customers for some of the larger types of machine tools, such as boiler shell drilling machines, the heavier types of radial drilling machines, and boring mills.

Some interesting new machine tools have made their appearance during the last few weeks. Among them is a double-ended lathe, specially designed for chucking and machining automobile rear axle cases, of the type that is divided on a vertical plane at the center. This machine is designed by Smith & Coventry, Ltd., Manchester, for a firm making small cars in large numbers. The work is held in a large hollow chuck at the center of the machine and the saddles and turret-slides carry tools that operate simultaneously on each end of the work. Not only is much time on double setting saved, but alignment and parallelism is insured.

Another interesting machine for turning, facing, and boring railway wheel centers has been built by the Leeds Wheel Axle Co., Ltd., Leeds. All the tools required for machining operate simultaneously. The machine is arranged somewhat like a vertical boring mill, but two machines are placed back to back on the same bed. The wheel centers are completed in the time taken for the longest operation, which is the rough- and finish-boring of the central hole.

Overseas Trade in Machine Tools

During June, the exports of machine tools amounted to 936 tons with a value of £111,900. These figures show a serious drop from those of the last four months, and are the second lowest in both tonnage and value for the last twelve months, only August of last year showing lower returns. The value per ton of exports rose from £109 in May to £120 in June.

Imports of machine tools during June rose in both tonnage and value, the figures being 420 tons and £62,247, respectively, while the value per ton remained at £148—the figure for May. The export tonnage for the current year is now equal to the years immediately prior to 1914, the corresponding value being 84 per cent above that of pre-war years.

Conditions in the General Engineering Industries

The engineering industry, as a whole, has not shown any further decline during the last month, and a few important sections have better prospects. Among these are textile machinery makers, two of the largest plants reporting that they have been on full time for two-thirds of the past year. The demand for textile machinery on the Continent is improving steadily, and South America is showing more activity, although Indian requirements are less, and in the Far East abnormal conditions militate against business.

The heavy electrical engineering field, although not quite so busy as during the past twelve months, continues to show to advantage among most other heavy branches. Colliery engineers, structural engineers, and makers of gas works equipment are fairly well off for orders.

In the locomotive building branch, foreign competition is being met successfully, and quality and good delivery generally is making up for the slightly higher prices that British makers ask. The total number of locomotives on order, however, is not large at the present time. Railway rolling stock builders have benefited recently by orders from home railways, while further important orders for rolling stock for Colonial railways are expected.

Hydraulic equipment builders are fairly busy; wheel presses, scrap bundling presses, and briquetting machinery form an important proportion of the work in hand. In the Leeds area, sheet-metal working shops are experiencing their busiest period since the war. Many of these works are running night and day, most of their output consists of automobile parts. Makers of cement and brick equipment are busy, and generally the light foundry and hardware trades are well occupied.

The shipbuilding tonnage under construction at the end of June in Great Britain and Ireland was approximately 1,093,000 or 72,000 tons less than was building at the end of March, and 423,000 tons less than in June last year. The total tonnage being built in other countries at the end of June was 1,276,000, about one-third of which was in German yards. In Great Britain, about one-third of the tonnage under construction at the end of June was to be driven by internal combustion engines.

The Iron and Steel Industry

The iron and steel industry is very inactive, and many firms find it almost impossible to keep their plants in operation. While some foreign steel makers are reported to be refusing orders, there is a complete lack of foreign orders for this country. There is a good home demand for iron and steel, but the orders are going to foreign iron and steel works, causing agitation for the protection of the industry. Keen competition is driving many firms to purchase Continental material, though they would prefer to do otherwise. The difference in price too often places the users of home material out of the market altogether, and when a firm finds its competitors securing business with the help of cheap Continental iron and steel, the only course open is to do likewise or close down.

The Machine-building Industries

THE volume of business in the manufacturing industries continues to run into high figures. In June, the last month for which complete statistics are available, the total production of the manufacturing industries in the United States, according to statistics collected by the Department of Commerce, was 25 per cent higher than the average production for 1919, and 20 per cent higher than for the corresponding month in 1924. The only industries reporting a decreased production, as compared with 1919, were those manufacturing textiles and leather goods; but even in these industries there was a marked improvement over the corresponding month a year ago, the output of the textile industry being over 30 per cent greater, and the leather industry showing an improvement of 10 per cent.

On the other hand, the output of the iron and steel industry was 7 per cent above the average for 1919, and 40 per cent greater than a year ago. The non-ferrous metal industries were 84 per cent in advance of 1919, and 16 per cent in advance of a year ago. The automobile industry, of course, led all others in the percentage of increase. The output of this industry was 141 per cent greater than in 1919, and 60 per cent greater than a year ago. There is also a smaller stock on hand of manufactured commodities, than there was a year ago.

The improvement in business conditions this year, as compared with 1924, is also in evidence in the reports of many large manufacturing companies. For example, the Westinghouse Electric & Mfg. Co. states that the orders received for the second quarter of this year totaled $42.432,000, as compared with $40,031,000 for the same period in 1924.

The Machine Tool Industry

The business in the machine tool field has been unusually well maintained during the summer months. Compared with the experience of the past year, most machine tool builders found business considerably better, and the general trend in the field is encouraging. The small tool industry has also experienced a satisfactory activity. The foreign trade in both machine tools and small tools, while not to be compared with the pre-war days, has nevertheless shown a great improvement over the past four years. Even Russia has been actively in the market, one of the recent noteworthy purchases being a very large quantity of twist drills.

The Iron and Steel Industry

In the iron and steel industry, the orders on hand, compared with past years, are very small, but the fact that the steel output averages about 65 per cent of the theoretical capacity indicates, nevertheless, a satisfactory condition, since this production is maintained largely by orders for immediate shipment. For three consecutive months there has also been an increase in the volume of unfinished orders. The demand for steel bars is greater than that for other forms of finished steel, indicating a continued demand from the automobile industry. The activity in the building field, requiring a large volume of structural steel, the activity of the agricultural machinery and implement manufacturers, and the large number of pipe line contracts placed during the first half of the year, are also expected to produce satisfactory business in the iron and steel field during the early fall, with well stabilized prices.

It should be pointed out that a 65 per cent operation of the theoretical capacity of the iron and steel industry must not be interpreted as a business "depression." On the contrary, a rate of operation of 60 per cent of capacity is considered as "normal" for the usual needs of the country. When operations go beyond this rate, it is because the demand is greater than normal and an expansion in manufacturing activities is taking place.

Operations during August have been so satisfactory that it is likely that this month will record the first increase in iron and steel production since last March. Several blast furnaces have been blown in and a number are scheduled soon to follow. The ingot production of the United States Steel Corporation has reached 70 per cent of capacity. Railroad buying is improving, and an increase in orders from both manufacturers and jobbers is noted.

The Automobile Industry

Automobile production, while showing the usual seasonal decline, is greater for this time of the year than ever before, and the general conditions in the industry are reported as quite satisfactory. Not only production but sales generally have also been better this summer than last year. For example, General Motors' dealers sold nearly 76,000 cars to users in June, compared with 65,200 cars during the same month last year. The company's sales to dealers were 71,000, as compared with 33,000 in 1924, evidencing much greater confidence on the part of the automobile distributing trade. The Dodge company reports net earnings, including unpaid taxes, for the first six months of the year, of $16,488,000 as compared with $9,110,000 last year.

Several price reductions have been announced with the appearance of new models. These reductions, however, are not caused by unsatisfactory business conditions, but rather by the reduced manufacturing costs made possible by improved equipment and a [illegible] and well-sustained volume of production.

On July 1 there were 17,458,377 motor vehicles registered in the United States, a gain of 13.7 per cent over a year ago.

Returning from a European trip early in August, John N. Willys, chairman of the Foreign Trade Committee of the National Automobile Chamber of Commerce, predicted that the export business in automobiles will play a very large part in the future of the American automotive industry, and stated that in his opinion, the United States will soon be shipping abroad one-quarter of the number of automobiles built. "It is my observation" he stated, "that Europe is now on the verge of a similar motor development to that which the United States experienced in the past ten years. In conversations with public officials abroad it was apparent that their point of view, which has regarded the automobile as a luxury, is rapidly shifting, and that they recognize a desire on the part of the mass of the people that motor travel shall be encouraged.

"The European, learning that more than 4,000,000 American farmers own motor vehicles and that there is one car to every other family in this country, raises the question of how he can also enjoy these conveniences. As a result there is a tendency towards more favorable tariff arrangements and taxation on a sound basis—rather than the punitive levies which now exist in many countries."

The Railroad Situation

Notwithstanding the fact that the railroads have had a very large number of surplus freight cars in good repair and immediately available for service during the past year, the greatest number of freight cars on record was placed in service during the first six months of this year, indicating that the railroads will be able to continue to give the same satisfactory and prompt freight service in the future as they have done during the past two years. The total number of freight cars installed during the first six months of the year was 83,291.

New Machinery and Tools

The Complete Monthly Record of New Metal-working Machinery

CINCINNATI PYRAMID-COLUMN MILLING MACHINES

Tapered roller bearings have been applied extensively in the speed mechanism of an improved line of pyramid-column milling machines being placed on the market by the Cincinnati Milling Machine Co., Cincinnati, Ohio, with a view to delivering more power at the cutting point of the machines with the same power input at the pulley. To ascertain how much power is saved by the use of the tapered roller bearings, two machines were built that were duplicate in every respect except that one was furnished with roller bearings, and the other with the best known type of plain bearings. Both machines were subjected to a series of tests, first with a Prony brake applied to the spindle, and second by actually cutting metal. The company states that the brake tests showed an average superiority of the machine equipped with roller bearings amounting to 15 per cent, and that the metal-cutting tests showed the roller bearing machine to be capable of removing from 12 to 20 per cent more pounds of metal per horsepower minute than the machine equipped with plain bearings.

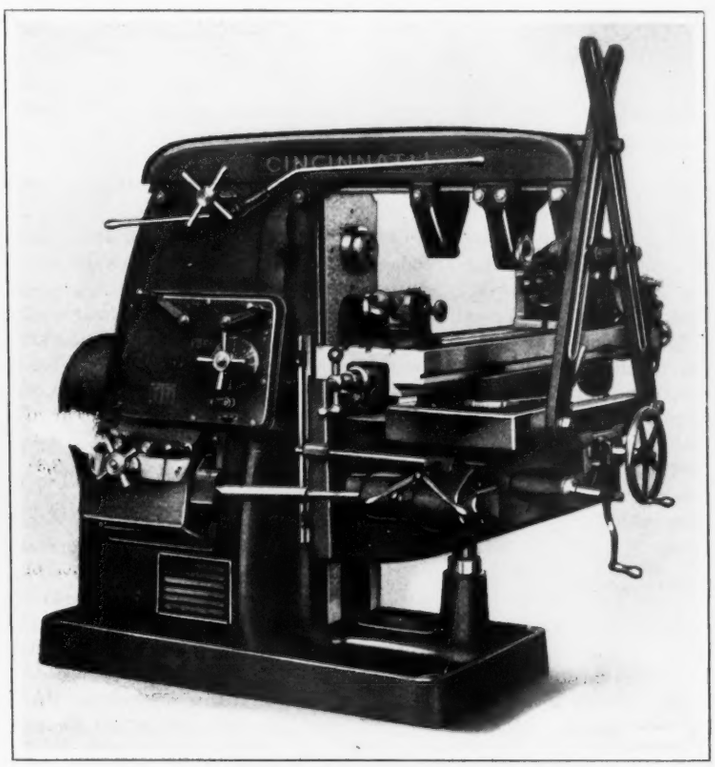


Fig. 1. Cincinnati "High-power" Pyramid-column Milling Machine

This new line consists of Nos. 1 and 2 type M machines, Nos. 2 and 3 "High-power" machines, and a No. 3 standard machine. Each size and type is built in plain and universal horizontal styles, and the Nos. 1 and 2 type M, and the No. 3 "High-power," in a vertical style. Many features are common to both machines, but on the "High-power" machines the feed-box is located on the side of the column, as illustrated in Figs. 1 and 3, whereas on the type M machines it is positioned on the side of the knee, as shown in Fig. 2. Another important difference is that the plain and vertical "High-power" machines are equipped with a power quick traverse, and the type M machines are not.

In addition to the features already mentioned, the machines are provided with an automatic oiling system in the column for the speed mechanism; a centralized oiling system for the knee, saddle, and table; an enclosed motor drive, unless an overhead belt drive is desired; a rear control; a sliding gear transmission; a multiple-disk clutch running in oil; and double starting levers. As in the previous designs of these machines, the rectangular over-arm is furnished on the horizontal styles. Adjustment of the over-arm is quickly accomplished in making set-ups, by means of a pilot wheel.

The pyramid-form column tapers gradually from the over-arm to the rim of the base which gives a shape that is said to provide maximum strength and rigidity. When the machine is motor-driven, the motor is entirely enclosed in the base and transmits power to the driving shaft through a silent chain. The motor is bolted to a flat plate which is machined on both sides and which, in turn, is bolted to a box section of the base in a manner that tends to eliminate vibration. Ample ventilation for the motor is obtained through vents in the sides of the column and in the rear cover of the column. There is provision for easily oiling the motor and adjusting its brushes through the vent holes, and replacement or realignment is also accomplished readily. An overhead belt drive may be arranged for at any time, in which case the belt is enclosed by a guard to a height of six feet above the floor.

The base forms a reservoir for the cutting lubricant which enters through removable drip-screens. Centralized oiling stations are furnished, from which individual tubes carry oil to all bearings in the knee, saddle, and table. These reservoirs can be filled once a day with a sufficient supply of oil for twenty-four hours of operation.

In designing the speed-change gears for these machines, the decision was reached to use the same general form of construction that is employed in the sliding transmission of an automobile. Fig. 4 shows a view of the speed-change unit supplied on the Nos. 2 and 3 "High-power" machines. These gears are carried on shafts having long integral splines and running in a tapered roller bearing at both ends. The type M speed-change unit is similar, but is built directly into the column. Twelve spindle speeds ranging from 20 to 419 revolutions per minute are available on the type M machines, and sixteen speeds ranging from 18 to 500 revolutions per minute on the "High-power" machines. There are never any gears in engagement except those actually providing the speed being used. All gears are made of alloy steel, heat-treated, and are oiled automatically, even though the machine spindle is stopped.

The driving clutch also follows the design of the multiple-disk clutch used in automobiles. An important point is that the clutch is non-adjustable, a heavy compression spring furnishing ample pressure to keep it functioning efficiently during the life of the machine. Simultaneously with the operation of the clutch control lever for disengaging the drive, a brake is applied to instantly stop the spindle rotation. The driving pulley runs in roller bearings.

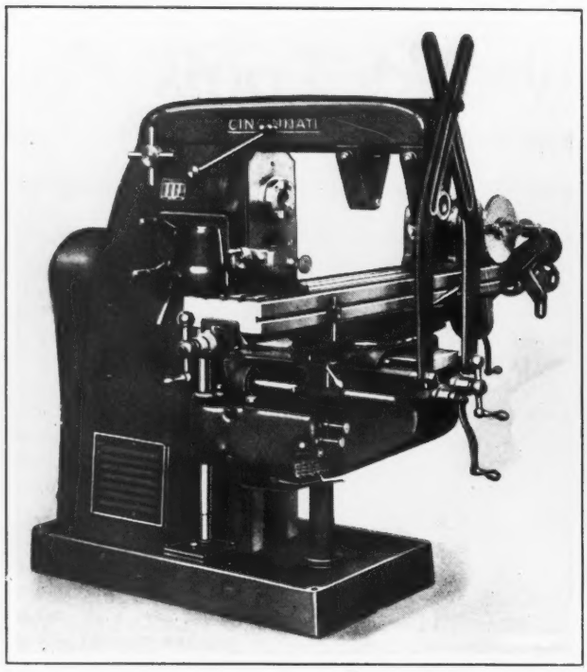


Fig. 2. Horizontal Type M Pyramid-column Milling Machine of the Universal Style

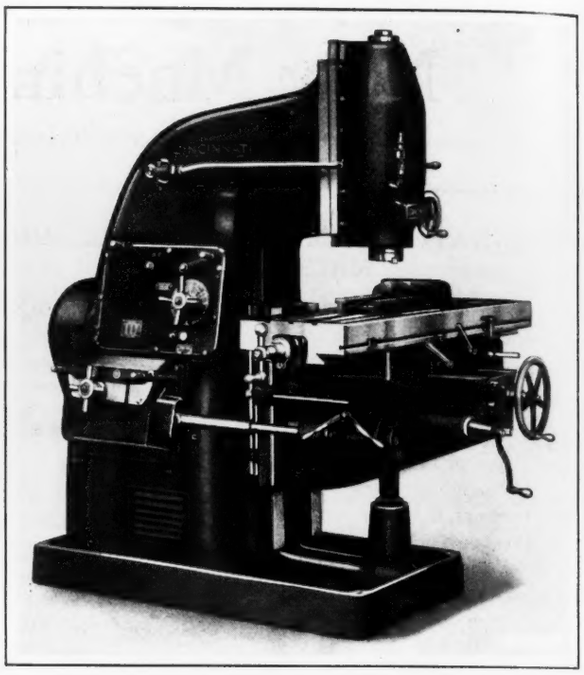


Fig. 3. Vertical "High-power" Pyramid-column Milling Machine with Movable Spindle Head

Twelve feeds ranging from 1/2 to 20 inches per minute are available on the type M machines through the feed-box on the side of the knee, and sixteen feeds from 1/2 to 20 inches per minute on the "High-power" machines through the feed-box on the side of the column. All control levers of the machines can be easily reached by the operator from the front of the machine. Starting levers are provided on both sides of the column extending well to the front of the machine and sufficiently high above any work to permit operations to be carried on without interference. The flanged end of the spindle and the taper hole are the same on all sizes of single-pulley machines, which means that face mills and arbors are interchangeable.

The Vertical Machines

From Fig. 3 it will be seen that the spindle of the No. 3 vertical "High-power" machine is carried in a removable head. This head is ordinarily arranged with a hand feed which may be actuated at a fast rate through a pilot wheel or at a slow rate through worm-gearing. For production operations, the entire head can be locked securely in any desired position. In tool-rooms it is often preferable to perform jig-boring and similar work by feeding the head rather than the knee, and for such requirements the head of this vertical machine can also be equipped with a power feed. In this case, a compact feed mechanism takes the place of the worm-box on the right-hand side of the head, and by means of sliding gears four feed changes are obtainable. The rates of feed are given on a plate in thousandths of an inch per revolution of the spindle. The power feed can be engaged in either direction.

On the type M vertical milling machines the spindle head is integral with the column, and is therefore always in a fixed position. This construction is followed because when the table is in its upper position it is not too high above the floor to prevent convenient chucking or to obstruct the view of the cutter in operation. The back-gears drive direct to spur gears keyed to the spindle, all gears being duplicates of those used in the horizontal machines. The main driving gear of the spindle is large in diameter to present a suitable drive for large face mills. A second series of gears furnishes high speeds for smaller cutters.

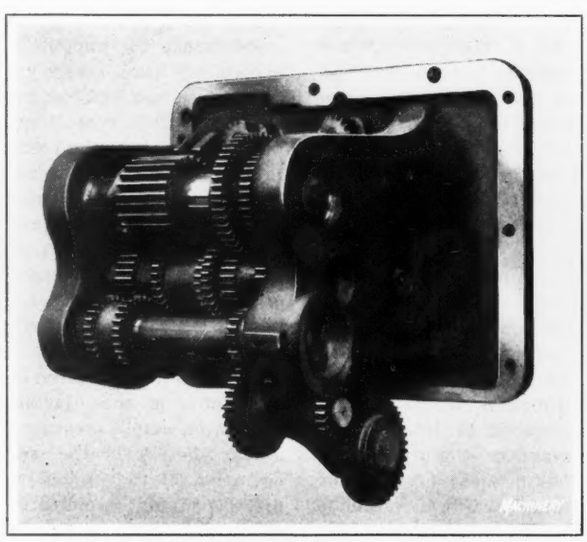


Fig. 4. Speed-change Unit on Nos. 2 and 3 "High-power" Machines

HEALD FULL-AUTOMATIC INTERNAL GRINDING MACHINE

The entire duty of the operator of a full automatic internal grinding machine now being introduced on the market by the Heald Machine Co., Worcester, Mass., consists merely of reloading the work and starting the machine. This machine is designed primarily for grinding the hole in such parts as ball bearings and gears manufactured in large quantities. Many of the units of the machine are identical with those of the semi-automatic machine described in July MACHINERY, but they are arranged to operate automatically.

After the operator has loaded the fixture and moved the starting throttle, the wheel-head advances toward the work at a high speed, automatically slows down to the grinding speed, and feeds into the work at any desired rate for the roughing cut. A size indicator which operates in the hole being ground controls further movements. As the hole approaches the finished size, an electric contact is made, operating levers that release a sliding dog *D*, Fig. 2, to allow the wheel-head to withdraw automatically from the work just far enough to permit dressing the wheel.

The diamond then drops into place, the table automatically slows down to the proper dressing speed, and the wheel is trued. Upon

the completion of the dressing, the grinding operation is immediately started again, the feed of the wheel changing to a fine finish feed, and the speed to the same or a slower rate than was previously employed. The wheel now continues to grind until the hole reaches the finished size, when a second electric contact is made to operate levers which control other dogs. The table and wheel-head then withdraw from the work at full speed, the work-head stops, the water is shut off, and the machine comes to rest, ready for another cycle of operations when the work has been reloaded.

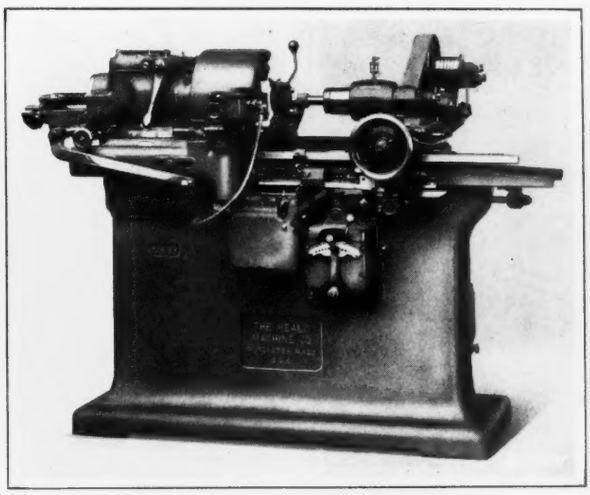


Fig. 1. Heald Internal Grinding Machine

Simplicity of control is one of the features of the machine, as may be seen from Fig. 2, which shows the cover of the control box removed and the sizing indicator swung out from the work. As the hole in the work approaches the finished size in an operation, the contact is made at *A*, Figs. 2, 3, and 5, to send electric current through magnet *B*, Fig. 2, which pulls down lever *C* and lifts a latch that controls sliding dog *D*. This allows the table stroke to be amplified just enough to make the wheel pass the diamond. At the same time that the lever operates the sliding dog, it opens a valve in cylinder *E*, allowing oil to flow through pipe *F* to the diamond bracket and push the diamond into position for truing. The arrangement of the truing diamond may be clearly seen in Fig. 3.

When the wheel has been trued, the diamond is raised into its normal position by a cam on the table, lever *C* and dog *D* return to their former positions, and the wheel continues to grind. The second contact is made at *G* when the finished size of the hole is reached, the electric current being sent into a second magnet directly in back of magnet *B*, which controls lever *H*. When this lever is pulled down against the magnet, it lifts dog *J* to allow the table to withdraw to the rest position. As the table travels toward this position, bar *K* strikes roll *L* and opens a pressure valve, causing the table to withdraw at full speed. When the operator has chucked a new piece, he simply throws lever *M* toward the left, after which the wheel returns to the work at full speed until bar *K* runs off roll *L*, when the wheel assumes a set grinding speed and the cycle of operations is gone through as before.

To control the delivery of the electric current to the correct magnet, there is a switch attached to the cover of the box, as shown in Fig. 1, which operates on terminals *N*, *O*, and *P*, Fig. 2, terminal *O* always being alive. Previous to the operation of the truing dog, the switch is across terminals *O* and *P*, but as the dog returns into position after the wheel has been trued, the switch is thrown across terminals *N* and *O* so that the current will pass into the second magnet which controls lever *H*. Fingers *R* and *S* operate the switch at the proper time.

The Work-head and Size Indicator

The work-head is of an all ball-bearing self-adjusting design. A large hole extends through the spindle to accommodate collet-operating tubes of either the push or pull type. It also enables a large volume of water to be supplied to the work, the water flowing through the hole and all over the inside to insure an even temperature. This feature is especially desirable in grinding hardened steel when a large amount of heat is created.

Fig. 3 shows the indicator in position with the diamond-pointed finger running on the surface of the hole. When the work is finished, the indicator box automatically swings out of the way, enabling the operator to easily reload the work. The position of the indicator box can be readily adjusted to suit various sizes of holes as regards both diameter and length. It can also be permanently swung out of the way when the operator desires to true up a new wheel or grind a master hole. The arrangement of the inside of the box can be seen in Fig. 5.

The automatic feed change of the cross-slide just before the truing of the grinding wheel, as well as the change in speed and the method of truing, is said to constitute a vital factor in obtaining a straight round hole without bell-mouth, and to be a big element in the production, since heavy roughing cuts can be taken without danger of producing holes that are over-size. The cross-slide is arranged

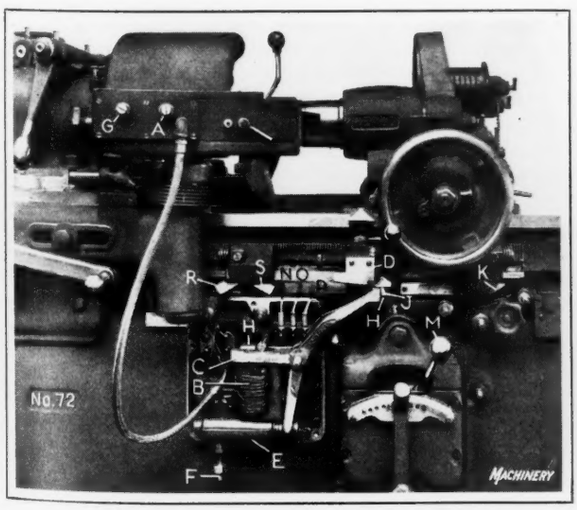


Fig. 2. Close-up View of the Magnet Control Box with the Cover removed

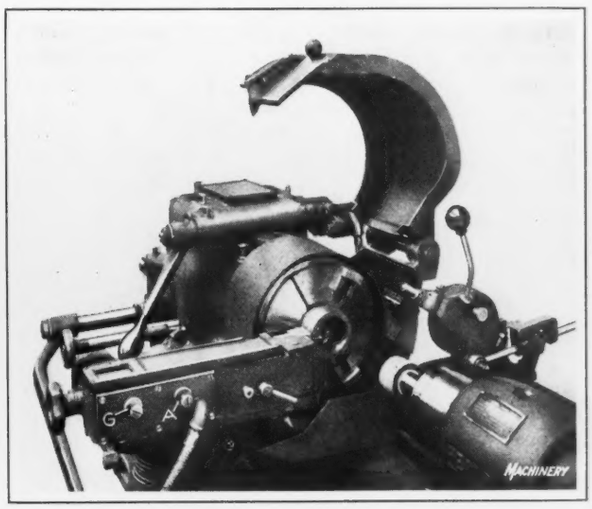


Fig. 3. Arrangement of the Sizing Indicator, Truing Diamond, and Wheel-head

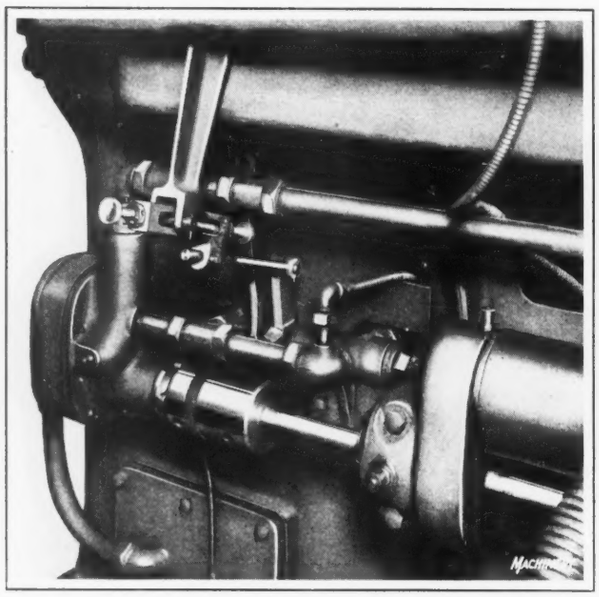


Fig. 4. Mechanism employed for slowing down the Table Speed

with a stop which assists the operator materially when it is necessary to change wheels and run the slide back to take care of the larger new wheel. It also gives him the correct position of the cross-slide relative to the work, so that he can start grinding immediately. The wheel truing device is rigidly constructed, positive in operation, and easily adjusted for position. It is so located as to always be out of the way when grinding. A smooth action is obtained by operating it hydraulically.

Operation of the Table

As in other Heald internal grinding machines, the table is driven by a simple hydraulic arrangement which permits the automatic changes in speed to be made at the proper time. For instance, the wheel-head comes up to the work at full speed from the rest position, changes to the desired grinding speed, changes again to the truing speed, and either continues at this truing speed for finish-grinding the work or returns to the former grinding speed; on coming out of the work when the hole is finished, it changes to full speed for returning the head to the rest position. These automatic changes in speed are obviously important in mass production.

The table movements are controlled by three dogs, two of which are set for the grinding stroke. The third—sliding member *D*—is automatically operated from the sizing indicator, as already mentioned, to allow the table to withdraw sufficiently to pass the wheel across the truing diamond. The dogs are provided with a micrometer adjustment, and their positions can be altered during an operation.

The "high-power" idler and wheel-head used on the standard and semi-automatic Heald hydraulic internal grinding machines are furnished on this full automatic. Any wheel-head most suited for the particular job for which the machine is intended, is furnished. The standard machine is driven by an overhead countershaft, although a two-motor drive can be readily applied. The countershaft runs in ball bearings, and all revolving shafts throughout the machine are mounted in ball or roller bearings. This machine has a capacity for grinding holes up to 6 inches in diameter by 6 inches deep; it requires a floor space of 49 1/2 by 90 inches, and weighs about 5500 pounds.

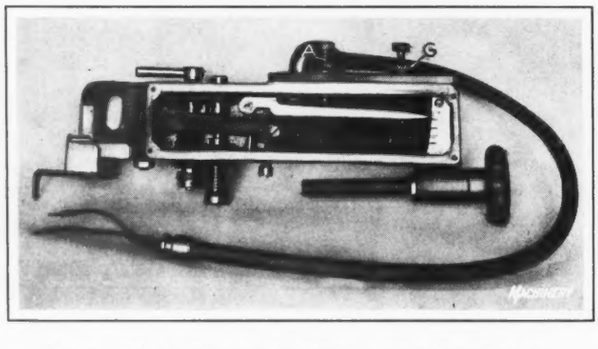


Fig. 5. Sizing Indicator with the Cover removed to show the Internal Construction

BRYANT SEMI-AUTOMATIC HOLE GRINDER

One of the important features of a small-size hole grinder recently developed by the Bryant Chucking Grinder Co., Springfield, Vt., is that only two levers are manipulated in its general operation. This feature, together with the use of compressed air for obtaining the semi-automatic operation, gives a high-production machine. The two levers are both operated by the left hand, so that the right hand is always free for gaging or handling work, and they are located so as to require a minimum amount of effort for moving them. Handle *A* is manipulated to engage and disengage the power traverse of the wheel-slide, to carry the wheel-slide into and out of the working position, and to start and stop the rotation of the work. Handle *G* is employed to open and close the work-holding chuck. The total chuck swing of this No. 3 machine is 6 1/2 inches, and the maximum grinding length, 2 inches.

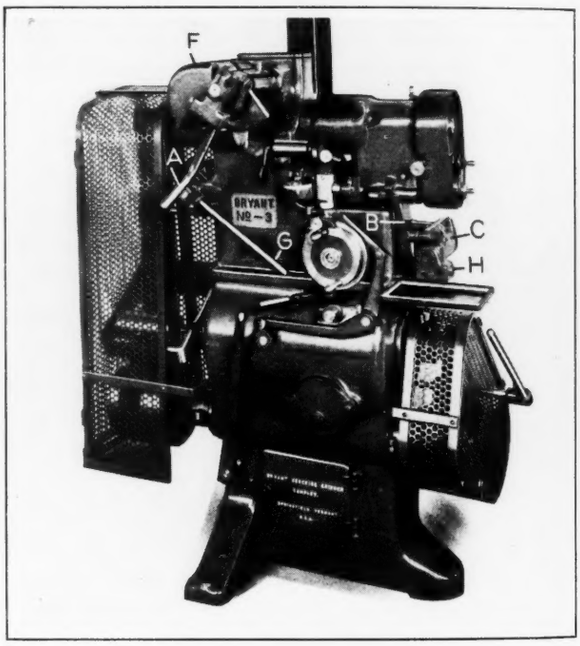


Fig. 1. Bryant Semi-automatic Hole Grinding Machine

The fundamental points of wheel-slide design embodied in other Bryant hole grinders are incorporated in the new machine. In Fig. 1, which shows a front view of the machine, the wheel is entering the work, while Fig. 2 shows the wheel-slide withdrawn well to the right and swung to the rear to permit inspecting the work. To bring the wheel-slide into the position illustrated in Fig. 2, lever *A* is pulled to the right, carrying the slide in the same direction until it engages arm *B*. The latter then shifts an air valve which, through piston *C*, swings the wheel-slide into the rear position. After the inspection of the work has been completed, handle *A* is moved to the left, again operating the air valve through arm *B*, and lowering the wheel-slide into the grinding position.

When lever *A* is moved into the extreme left-hand position, a lug *D*, Fig. 3, engages a notch in the bellcrank *E*, which,

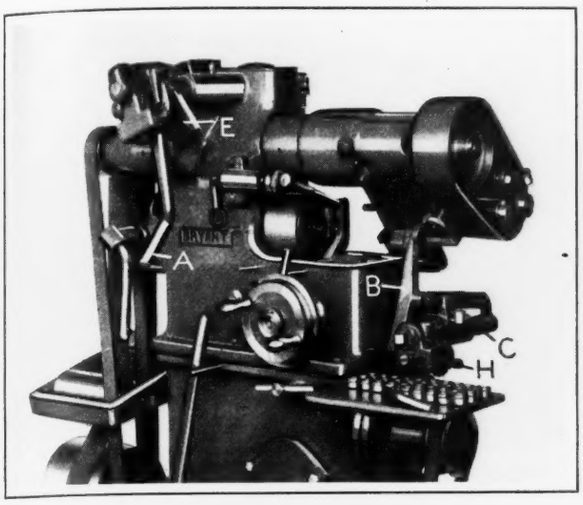


Fig. 2. View showing Wheel-slide swung to the Rear to permit inspecting or changing Work

in turn, is driven by a connecting-rod from a gear crank under guard *F*. When this engagement has been accomplished, the power traverse of the wheel-slide starts. Also, at the same time that piston *C* is operated through arm *B* to swing the wheel-slide into the rear position, a second piston is operated by air at the rear of the machine, which lifts the work-pulley cradle to release the driving belt. Simultaneously, a third air-operated piston functions to stop the rotation of the work-spindle. On the reverse movement of handle *A*, the work-pulley cradle is dropped, and the work-spindle started at the same time that the wheel-slide is swung into the grinding position. Air at a pressure of 60 pounds per square inch is admitted into the machine at *H*. All the pistons are small, so that little air is used. A hand-lever is also provided for stopping the rotation of the work independently of the air control, but this lever is not generally used in production grinding.

The sizing indicator is shown in the grinding position at *L* in Fig. 3. This indicator can be used on holes above 3/4 inch in diameter, with the wheel grinding. On holes under this size, the indicator can be used in place of a hand plug, but it is not used when the wheel is grinding. Fig. 1 shows the indicator swung outward to permit the chucking of work. Only one rate of power feed is provided. The machine can be driven from a motor mounted on an adjustable plate bolted to the back of the bed, or from a countershaft mounted on the adjustable plate. The work-spindle may be run at 750 or 1200 revolutions per minute. The weight of the machine is about 1460 pounds, and the floor space required, 2 1/2 by 3 feet.

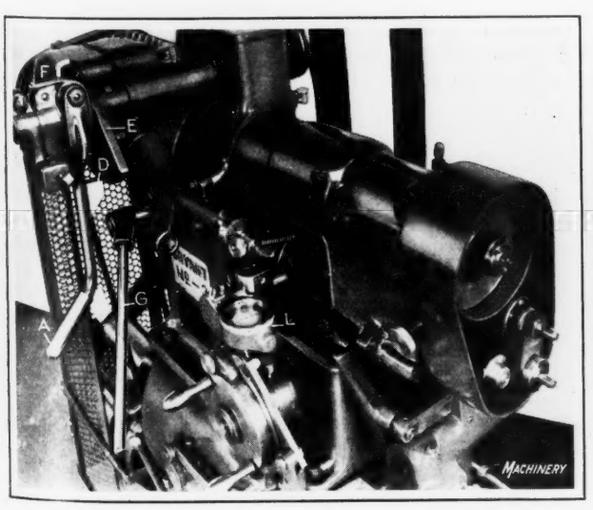


Fig. 3. Close-up View of the Sizing Indicator in the Grinding Position

BROWN RECORDING PYROMETER

Several new features are incorporated in a recording pyrometer developed by the Brown Instrument Co., Philadelphia, Pa. This instrument is built to make either a single record, two records side by side, or, when in a multiple form, as many as twelve records on one chart. The instrument is contained in a die-cast black-enameled aluminum case, 15 inches high, 14 inches wide, and 9 inches deep. The chart is 7 inches wide.

A free-swinging pointer is depressed at intervals of thirty seconds on a carbon or inked ribbon to produce a mark on the chart. The marking ribbon is above the paper so that the mark is produced on the front side of the paper where it shows clearly, and the marks are so close together as to form a continuous line. The marking ribbon and chart last two months, and no inking is necessary. In the single and duplex recorders, the marking ribbon is moved back after each mark is made so as to permit the last impression to be clearly visible.

A platen is supplied to facilitate making notes on the chart with a pen or pencil, and a glass knife-edge located directly below the driving roll, provides for readily tearing

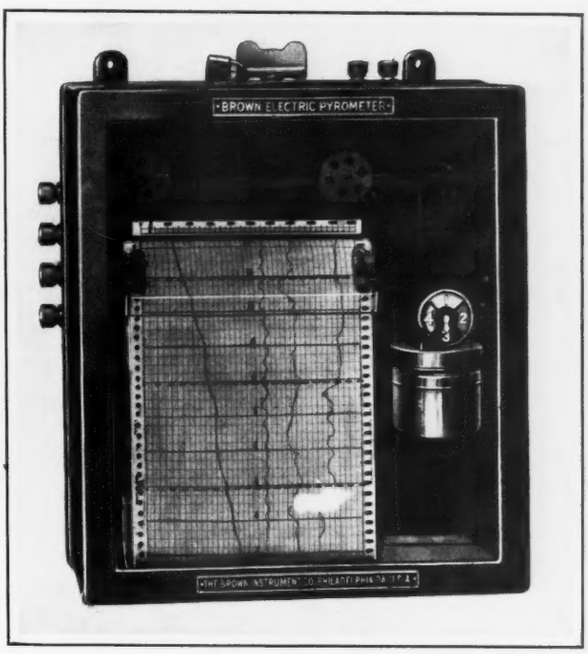


Fig. 1. Brown Pyrometer built for Single, Duplex, or Multiple Recording

off the paper. The paper can be torn off two hours after the last impression has been made; for example, a complete record of twenty-four hours ending at 6 o'clock A. M. can be torn off about 8 o'clock A. M. The galvanometer and the recording chart mechanism are carried on a hinged frame. When the instrument is swung aside, as illustrated in Fig. 2, the galvanometer is accessible. In addition to the chart for recording temperatures, there is an indicating scale having large figures that are legible at a considerable distance. The chart has rectangular coordinates with time lines running straight across.

The recorder is driven by an electric clock if alternating current is available, but for installations where this current cannot be employed, a hand-wound clock can be supplied. The standard chart speed is 1 inch per hour, but by reversing two gears, a speed of 4 inches per hour is obtainable, and other speed combinations can be had from 1/4 to 6 inches per hour.

As a pyrometer, the instrument incorporates an automatic cold-junction compensation, including the Brown patented index for adjusting a compensated pyrometer to the correct initial starting point on an open circuit. As a multiple recorder, the instrument incorporates a switch on which

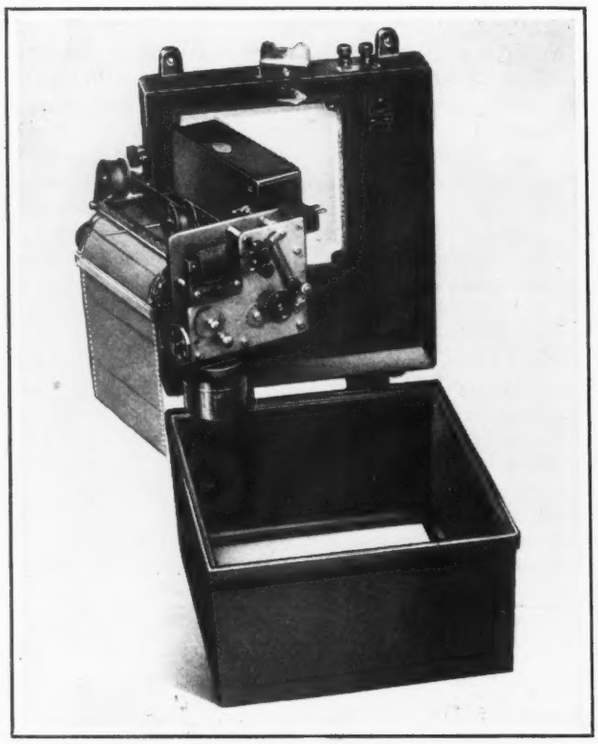


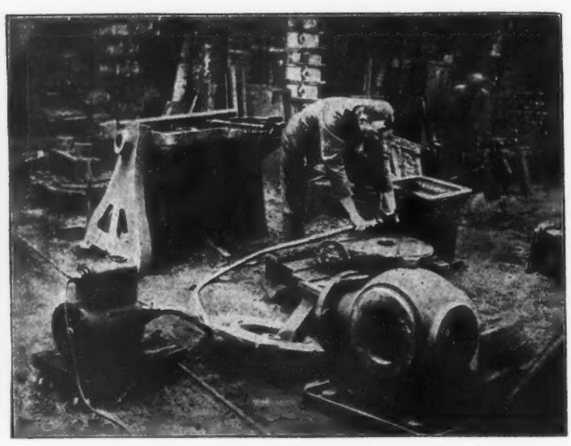
Fig. 2. View showing the Accessibility of the Galvanometer

there is a dial that indicates the number of the thermocouple or furnace being recorded at the time. The record lines are made in different color combinations on the chart, and the switch dial is numbered and colored to correspond.

BIAX FLEXIBLE SHAFT EQUIPMENTS

Flexible-shaft driven equipments are now being introduced on the market by the Biax Flexible Shaft Co., Inc., 136 Liberty St., New York City, for a large variety of operations, such as grinding, drilling, polishing, screwdriving, and nut-setting. These equipments may be motor-driven and portable, as shown in the illustration, where an equipment is being used for snagging castings, or they may be provided with tight and loose pulleys mounted on a pedestal that is intended for fastening to a bench. A stepped pulley can also be mounted on a pedestal for driving, or a single-groove pulley may be used. Universal couplings are made for driving the flexible shaft by a portable electric drill or a motor not furnished with the equipment.

The flexible shafts are made of spring steel wire that can be bent in any manner without breaking or kinking. They are fitted in steel tubes, all sizes of which have a flat wire packing to increase the strength. The shafts are made in various diameters from 1/8 to 1 3/16 inches, and in lengths up to 30 feet.



Biax Flexible-shaft Equipment being used with a Wire Brush

Attached to each shaft is a fitting having a Morse taper socket for interchangeably receiving the shanks of tools and hand-pieces. This fitting may be of a design embodying a clutch, so that a tool may be started and stopped quickly close to the work without the loss of time that occurs when the operator must go to the motor to start and stop the shaft. This fitting is equipped with four ball bearings. Grinding wheels may be furnished with a ball-bearing hand-piece which permits the operator to support the wheel with both hands.

BRADY DISK PLANER AND JOINTER

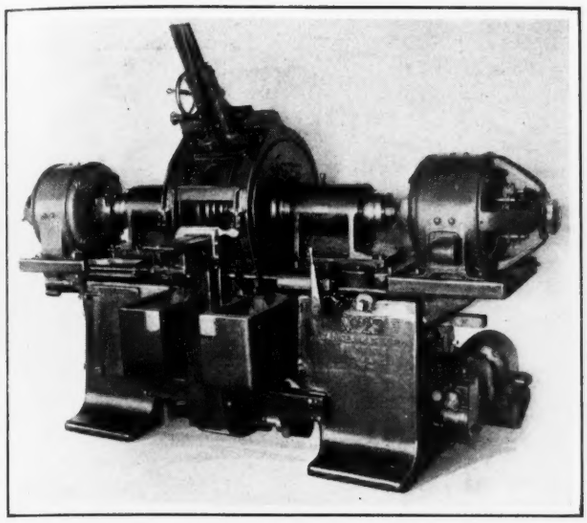
The important feature of the Brady disk planer and jointer placed on the market by the Challenge Machinery Co., Grand Haven, Mich., is the unusual arrangement of the cutter knives. Instead of the knives being held in a cylinder revolving in a horizontal plane, there are many knives set perpendicular in a 10-inch disk. These knives revolve counter-clockwise, parallel to the surface of the table, around a circular opening only 3/8 inch wide. With this design, a man's fingers cannot be drawn into the machine. The "cutter frequency" is rated as 32,400 knives per minute.

In the accompanying illustration the machine is shown with the base door removed so as to enable the motor, driving mechanism, and knife-head adjustment to be seen. Pieces may be planed with the correct draft of patterns by means of the tilting bed, and the machine is also equipped with a sliding angle-gage. The weight of the machine, including the motor, is about 325 pounds.

Brady Disk Planer and Jointer with Perpendicular Knives

POWER-OPERATED BENCH REAMER

A power-driven bench reamer intended for reaming such parts as bushings, spring shackles, connecting-rods, and pistons, has recently been brought out by the George H. Blettner Co., 1841 W. Jackson Blvd., Chicago, Ill. This machine has sufficient capacity to remove 0.020 inch of stock at each pass of the reamer through bronze bushings up to 1 1/2 inches in diameter and babbitt bushings up to 2 1/2 inches in diameter. The spindle is equipped with a geared scroll chuck which accommodates reamer shanks up to 1 1/4 inches. The machine is driven by means of a Westinghouse 1/4-horsepower motor mounted on a base, a spindle speed of 38 revolutions per minute being obtained by means of a balanced gear reduction which runs in oil. This equipment occupies a bench space of only 7 by 15 inches.



Gardner Double-spindle Disk Grinder equipped with an Oilgear Feed

GARDNER OILGEAR-FEED DOUBLE-SPINDLE DISK GRINDER

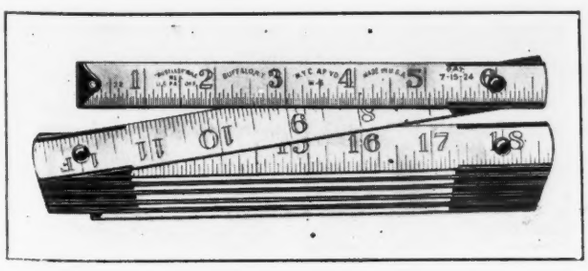
A No. 27 double-spindle disk grinding machine equipped with an Oilgear feed has recently been brought out by the Gardner Machine Co., Beloit, Wis. This machine is of the same general construction as the one illustrated in April, 1924, MACHINERY, except that it is longer and heavier so as to accommodate longer work. It will take work of any size up to 12 inches in length, whereas the standard machine only handles parts from 3/4 to 8 1/4 inches long. Twenty-inch steel disk wheels interchangeable with 18-inch shallow-type ring-wheel chucks are provided.

The base of the machine is longer and proportionately heavier, and in order to obtain a longer travel of the grinding heads, a longer oil cylinder is used. The motor-driven type of machine is equipped with two 10-horsepower motors. The ways in the sub-base which carries the grinding heads, have been lengthened to 25 inches, which is 9 inches longer than on the standard machine. This construction not only permits a greater opening between the grinding members, but results in a reduction in wear of the surfaces. Both heads are equipped with an individual adjustment to compensate for uneven wear of the grinding members.

The hood enclosing the grinding members is of a telescoping type that permits a maximum opening between the grinding members with a minimum overhang. The upper half of the hood is hinged to make the grinding members easily accessible. The dressing device is the same as is used on the standard machine. This machine weighs about 6500 pounds, and occupies a floor space of 8 by 12 feet.

RUSTLESS RULES

Two new rules made from an aluminum alloy, which are said to be non-breakable and impervious to rust, are manufactured by the Rustless Rule Co., Inc., 9-11 Lafayette Ave., Buffalo, N. Y. One of these rules consists of 6-inch sections, while the other is a vest-pocket size made up of a series of 4-inch sections. Both rules are graduated on the front and back in sixteenths of an inch, with the exception of the end sections, which are graduated in thirty-seconds of an inch.



Aluminum Non-corrosive Rule

The end of each section is relieved and tapered in order to have a tight fit in a male or female spring-brass clip. When these clips are assembled, flanges overlap the beveled edges of each aluminum section and meet flush with the body portion. With this design, each clip becomes immovable and a solid part of the section to which it is attached. The clips are so constructed that there are only two common bearing points, rather than an over-all bearing surface. In assembling the rule, the brass rivets at the section joints are forced in by spinning over a washer. The large rule is made in 3-, 4-, 5-, and 6-foot lengths, and the vest-pocket rule in 2- and 3-foot lengths. A combination metric and English vest-pocket rule, a metric rule one meter long, and a 6-inch caliper rule are also made from the same aluminum alloy.

PEDRICK MOTOR-DRIVEN PIPE BENDER

The pipe benders made in the past by the Pedrick Tool & Machine Co., 3638-42 N. Lawrence St., Philadelphia, Pa., have all been hand-operated, but this company is now placing on the market a motor-driven machine for bending pipe up to 2 inches. The faceplate of this machine is in a horizontal plane, and is geared to revolve within the cavity of the table in such a way that the gear teeth are entirely covered and guarded. The bending roll is bolted stationary on the central stud, and a bending arm which moves with the faceplate shapes the pipe around the roll.

Pedrick Horizontal Motor-driven Pipe Bender

One end of the pipe rests against a small saddle located on the resistance arm. The latter may be held in various radial positions by means of a dowel-pin which is inserted in different holes in the face of the table. With this construction, the bending arm and the resistance arm may be brought close together for the purpose of bending short pieces of pipe which, perhaps, may already be threaded. A stop-piece is bolted to the faceplate to permit bending any quantity of pipes uniformly to the same shape.

Almost any shape of pipe may be obtained with one size of roll. The roll is grooved to suit the diameter of the pipe to be bent and governs the radius of the bend, while the arc through which the faceplate is turned, controls the degree

Fig. 1. Landis Double-head Threading Machine

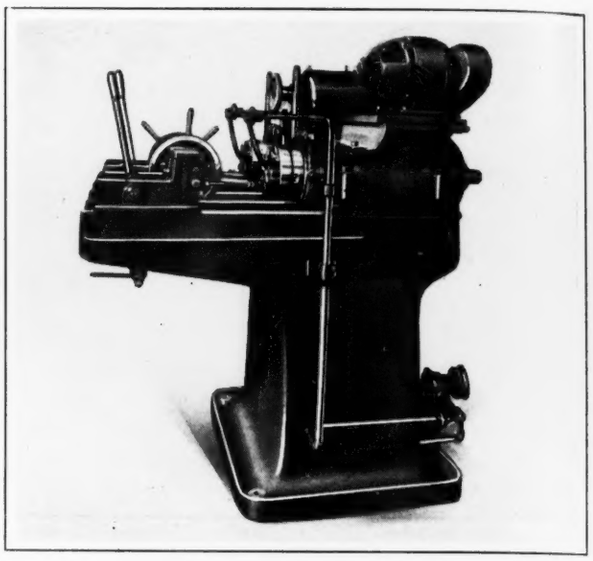


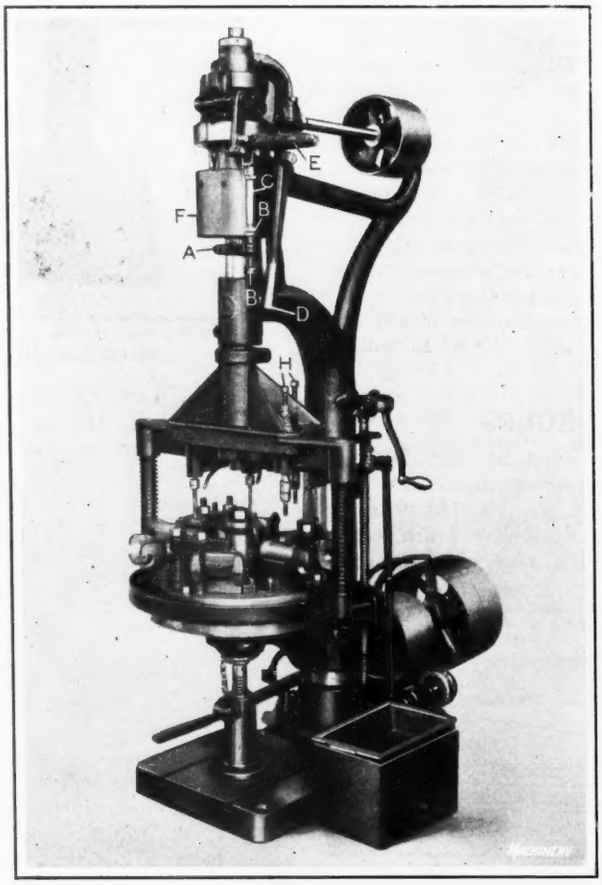
Fig. 2. Threading Machine equipped with Motor Drive

or angle of the bend. Hence a right-angle bend is made by revolving the faceplate 90 degrees. The horizontal table is convenient for laying out and measuring work, and it permits the bending of long pieces such as hand-rails, at the middle.

LANDIS DOUBLE-HEAD THREADING MACHINE

A 1/2-inch double-head threading machine being placed on the market by the Landis Machine Co., Waynesboro, Pa., closely follows the design of the single-head threading machine built by this company, which was described in July MACHINERY. In addition to cutting external threads, the machine may be used for tapping nuts, either right- or left-hand, from 1/4 to 2 inches in size. The machine is equipped with a geared headstock and a single-pulley drive. It may be furnished with a motor drive, in which case the power is transmitted from the motor shaft to the drive shaft of the machine by means of a belt. As illustrated in Fig. 2, the motor is mounted on a plate on top of the headstock so as to economize in floor space and prevent dirt and oil from accumulating on the motor parts. A 1 1/2-horsepower motor running at 1200 revolutions per minute is required.

As on the single-head machine there are four speeds of 157, 226, 315, and 441 revolutions per minute for the die-head. A lead-screw attachment may be furnished prior to placing the machine in service, only one lead-screw being required for each carriage. Changes in pitch are taken care of by a substitution of gears. Opening and closing of the die-head are automatically accomplished at predetermined limits by the carriage or by hand. There is a horizontal sidewise adjustment for the vise, and a vertical centering adjustment. A supply of cooling lubricant is maintained at the die-head by a rotary pump, and there is a valve at the die-head for shutting off the supply when necessary. The weight of the belt-driven machine is about 1300 pounds, and the weight of the motor-driven machine, 1750 pounds.



Hoefer Machine arranged for drilling and tapping Universal-joint Yokes

HOEFER DRILLING AND TAPPING MACHINE

High rates of production can often be obtained by equipping standard drilling machines with auxiliary heads and special fixtures. This is the case with the machine here illustrated, which was built by the Hoefer Mfg. Co., Inc., Freeport, Ill., for drilling and tapping a hole in the shank of universal-joint yokes. The entire unit consists of a 23-inch drilling machine equipped with a geared tapping mechanism. The arrangement is standard except that a plain wide-faced pulley is provided for driving instead of a cone pulley, the latter being unnecessary because changes of speed are not required. Also, a special feed mechanism replaces the regular mechanism.

In order to relieve the operator of controlling the tapping mechanism manually, the latter is equipped with an automatic tripping collar *A* which operates against adjustable nuts *B*, thus moving rod *C* and throwing clutch lever *D* to trip the spindle and automatically reverse the machine for tapping. The action of rod *C* is assisted by spring *E*. When the spindle reaches its uppermost position, the clutch is brought into neutral, ready for the operator to start a new cycle.

Since the work is of tough material and the threads of a

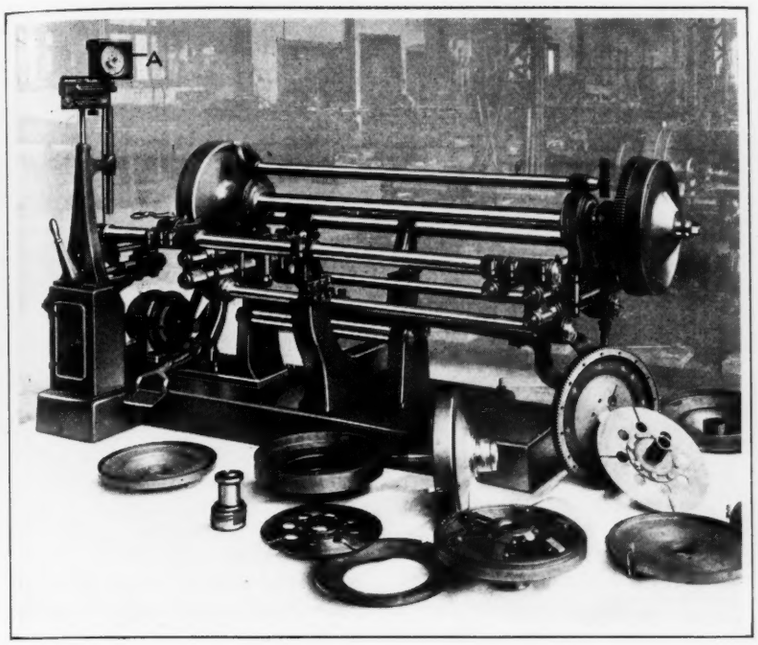


Fig. 1. Gisholt Precision Balancing Machine designed for handling Flywheels, Pulleys, and Other Short Parts

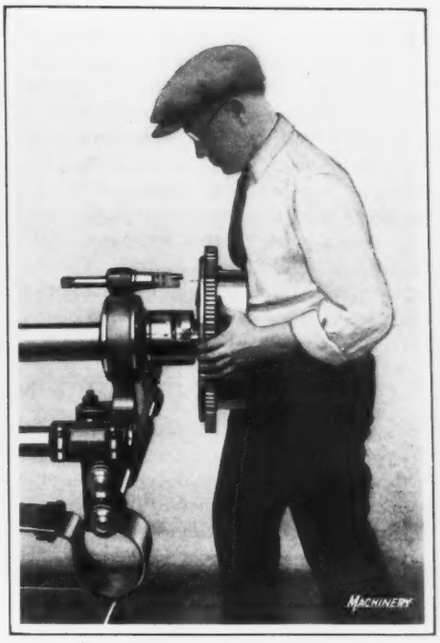


Fig. 2. View of Simple Adapter which makes Loading and Unloading an Easy Matter

fine pitch, it was deemed necessary to provide a positive feed so as to prevent stripping the threads. Hence the machine is equipped with feed-gears covered by plate *F*. The gear on the spindle is of a sleeve design, and made of bronze with an internal thread that engages a corresponding thread on the drill spindle.

By giving a proper ratio to the gears used for driving the drill spindles, a speed and feed per revolution were obtained which work satisfactorily with the taps whose feed is a fixed factor. The drills are held in special collets which have a vertical adjustment permitting compensation for grinding the drills. Vertical adjustment of the taps is accomplished by means of screws *H*, and the taps also have a limited vertical float.

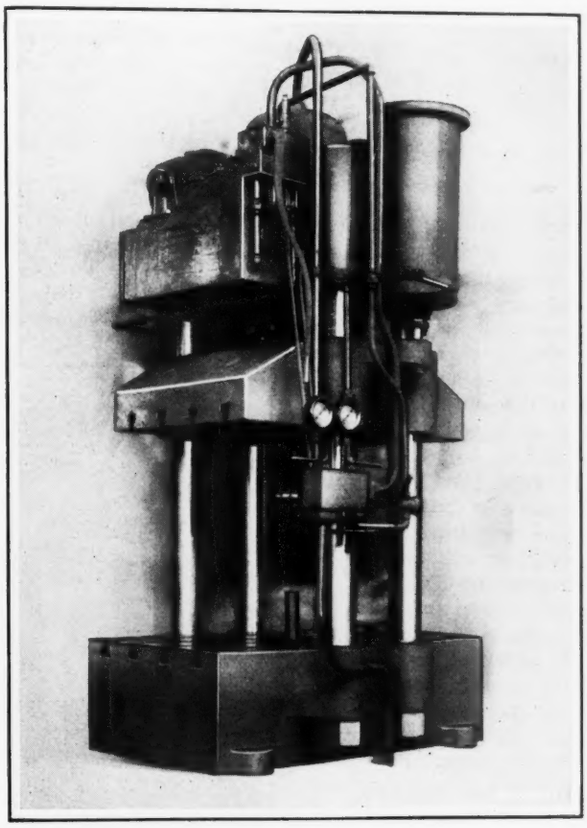
The indexing table is rotated by hand, and is provided with a plunger pin, operated through a foot-lever. Three sets of holding fixtures of two units each are mounted on the rotating table, so that when all fixtures are filled the table carries six universal-joint yokes. At the first station the fixtures are unloaded and loaded; at the second, the pieces are drilled through guide bushings; and at the third, they are tapped. At each indexing, two pieces are finished. Depending upon the thickness of the metal drilled, the capacity of this equipment ranges from four to seven yokes drilled and tapped per minute.

GISHOLT BALANCING MACHINE

A precision balancing machine especially designed for short work, such as flywheels, pulleys, fans, and clutches, is now built by the Gisholt Machine Co., Madison, Wis. This machine employs the same patented process as the standard crankshaft balancing machine described in the May, 1925, and July, 1923, numbers of MACHINERY. It may be used for parts up to 50 inches in diameter and 300 pounds in weight.

The machine measures the amount of unbalance in the part, and then locates the point where the balancing correction should be made. The exactness of the readings can be definitely checked by weighing, on separate scales, the material applied or removed to make the correction. The process employed for locating the angular position of the correction is also one of mathematical correctness.

One of the important new features is the recording amplimeter *A*, Fig. 1, which enables one man to operate more than one balancing machine. This amplimeter automatically records the readings of the machine, and thus while one machine measures or locates the unbalance in a part, the operator can load, unload, or operate a second machine or make balancing corrections on parts already examined. A simple adapter that facilitates rapid loading and unloading is clearly illustrated in Fig. 2.



Chambersburg Self-contained Hydraulic Press equipped with Pneumatic Pull-backs

CHAMBERSBURG PRESS

A self-contained hydraulic press designed particularly for forming and pressing parts in dies is being built in various sizes from 200 tons upward, by the Chambersburg Engineering Co., Chambersburg, Pa. The 300-ton, four-column size of this press is shown in the accompanying illustration. Railroads and car shops use this ma-

chine for producing car diaphragms, stiffeners, gussets, etc., and for bending and straightening such pieces as sills and plates. The press is operated at a high speed by utilizing shop air pressure for moving the platen and for stripping the ram to and from the work, and by doing the actual pressing by means of a hydraulic pump mounted on the upper platen.

Except for the four columns and a pneumatic pull-back, the press is of the same construction as the standard bushing presses built by this company, which possess features of accessibility and easy control. The general design of the press permits installations to be made to meet the individual needs of railroad, automotive, and general machine shops.

"UNISHEAR" CUTTING MACHINE

For cutting metals, leather, celluloid, and other materials in sheet form into any shape, the Unishear Co., Inc., 170 Fifth Ave., New York City, has placed on the market the motor-driven machine here illustrated. This "Unishear" is designed to have the same cutting effect as a pair of hand shears, but as it is motor-driven, sheets can be cut much more rapidly; for instance, No. 16 gage sheet steel has been cut as fast as five yards per minute. With this equipment there can be no loss of material, because there are no chips,

"Unishear" Motor-driven Sheet-cutting Machine

and sheets are severed without burrs. Material up to 5/64 inch thick can be cut.

The motor is of 1/3 horsepower capacity, and is of the universal type, operating on either alternating or direct current of 110 or 220 volts. It runs at 5000 revolutions per minute and, through reduction gearing, drives a lower knife blade which is eccentrically mounted in a steel forging at the left-hand end of the machine. In this steel forging there is also an upper stationary knife blade, in relation to which the lower knife is oscillated up and down by the eccentric, to cut sheets fed between the two knives. The lower knife is operated about 1500 times per minute. As the knives close only for a distance of about 1/4 inch near their rear ends, there is no danger of the operator cutting his fingers. The blades are about 2 inches long and easily replaceable.

Because of the design of the steel forging in which the knives are contained, sheets can be cut to various designs, in addition to straight, provided the radius of curves is not less than 4 inches. The action of the eccentric arrangement tends to assist in feeding the material, but the movement of sheets can also be stopped immediately, which is of advantage in certain operations, such as cutting notches. Both ends of the motor-armature shaft are mounted in ball bearings, and the motor is amply ventilated. The knives are made of high-speed steel. As the weight of the "Unishear" is only about 38 pounds, it is readily portable. It measures 12 inches long by 12 inches wide by 10 inches high.

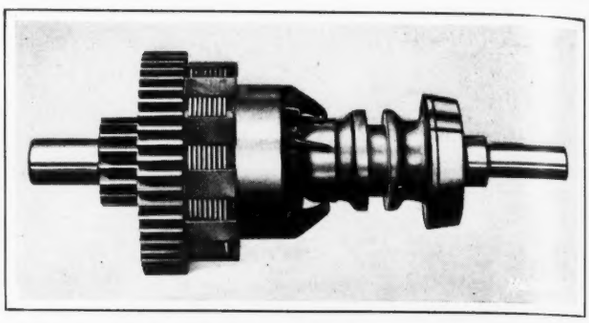


Fig. 1. Multiple Disk Friction Clutch incorporated in All Kearney & Trecker Milling Machines

MILWAUKEE MILLING MACHINES

The power rapid traverse to the table, multiple disk clutch, adjustable starting lever, centralized oiling system for the saddle and table, and independent table feed control, which constitute features of the motor-in-base milling machines built by the Kearney & Trecker Corporation, Milwaukee, Wis., and described in January MACHINERY, are now included in all models of Milwaukee milling machines. The power rapid traverse to the table is controlled by a long lever on the right-hand side of the knee. Raising this lever causes the table to travel at the rate of 100 inches per minute in the direction in which the table power feed is engaged, and when the lever is released, the normal feed is resumed.

The multiple disk clutch, shown in Fig. 1, is designed to work continuously under a full load. The disks are amply separated when disengaged so as to eliminate all tendencies to drift. A cone-type brake is provided for stopping the spindle quickly. The adjustable starting lever that operates the friction clutch extends to the front of the machine on the left-hand side of the double over-arms. This lever may be adjusted to any angle, as will be apparent from Fig. 2, to suit the convenience of the operator, or it may be swung completely out of the way to accommodate large work.

The centralized table feed control is operated by means of a single lever at the front of the table, which engages the automatic longitudinal feed in a direction determined by the lever movement. The action is independent of either the cross or vertical feeds. At the front of the table on the right-hand side, there is an oil reservoir fitted with tubing which leads to all important wearing surfaces in the table and saddle.

In addition to these changes in design, the Kearney & Trecker Corporation has made additions to its line of milling machines so that all models and sizes—Nos. 1 to 4—can be obtained with the enclosed motor-in-base drive. Hence, a single-pulley belt drive, external-bracket motor drive, and motor-in-base drive are optional on all machines.

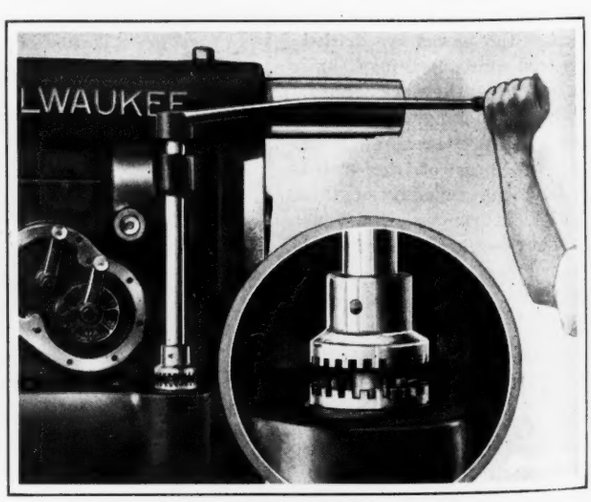


Fig. 2. Clutch Starting Lever which can be adjusted to Any Angle to suit the Convenience of the Operator

Elwell-Parker Tructor with Tilting Uprights

ELWELL-PARKER TRUCTOR

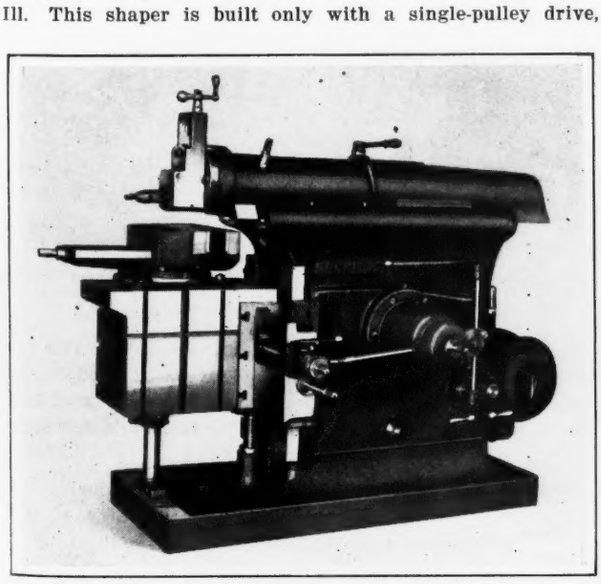
A tructor especially designed for handling sheet metal, plates, heat-treating boxes, motors, etc., has recently been placed on the market by the Elwell-Parker Electric Co., Cleveland, Ohio. As may be seen in the illustration, this tructor is equipped with two uprights which may be tilted to an angle of 40 degrees for carrying sheets or plates in an inclined position. The vertical and rocking motion of the forks is obtained by means of a double-drum electric hoist, in which the upper drum rocks the frame while the lower drum elevates the load.

The upper-drum cable pulls the upright against the action of a pair of heavy springs. These springs, with the cable, form a cushion rest for the load, and when the cable is fully paid out, the uprights pitch forward slightly to throw the tips of the forks downward for insertion beneath the load. All four wheels of the tructor can be steered so as to permit turning it in congested spaces.

ROCKFORD IMPROVED SHAPER

Convenience of control and compactness are the new features of the improved constant-speed shaper that has recently been brought out by the Rockford Machine Tool Co., Rockford, Ill. This shaper is built only with a single-pulley drive, so as to eliminate the necessity of a countershaft and its belts. A motor drive can be readily applied by replacing the friction pulley with a stock friction gear and rawhide pinion, and mounting the motor on the finished surface at the back of the column, as illustrated.

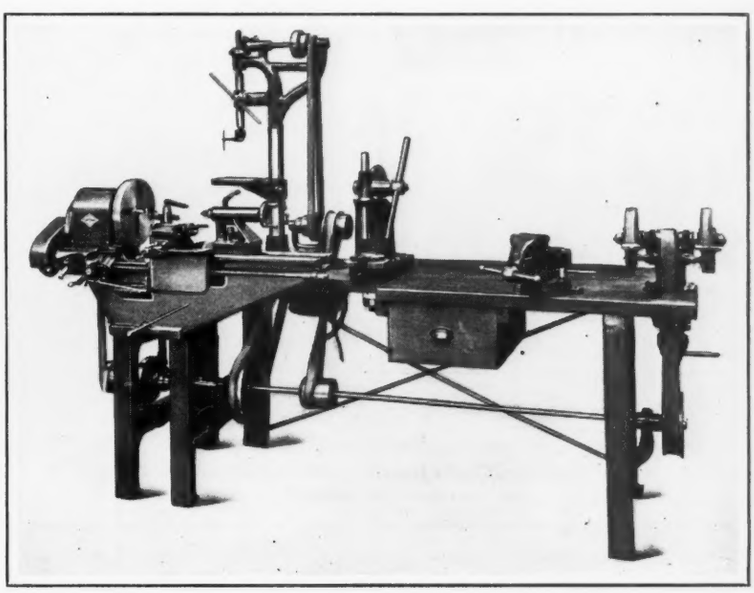
The speed transmission gears are assembled in the column, and the changes are conveniently selected from the operator's side of the machine. Only the gears in use are in mesh. The feed has been changed from the crank motion to the direct-driven type. Twenty-five changes, from 0.008 to 0.250 inch, evenly spaced, may be selected through a dial. The feed in either direction, and the neutral, are controlled by a hand-lever. An automatic stop for the feeds safeguards the work and the machine and also allows one operator to attend a battery of shapers. Angular ways are provided on the ram, which have a simplified method of adjusting for wear. The rocker arm is made of semi-steel.



Rockford Constant-speed Shaper of Improved Design

ARTISAN "METAL-WORKER"

A bench equipped with a lathe, drill press, arbor press, machinist's vise, emery-wheel stand, driving motor, and all necessary shafting is being placed on the market by the Artisan Mfg. Co., Cincinnati, Ohio, under the name of "Metal-Worker." The top of the bench is made of hard wood, is 7 feet long by 30 inches wide, and is bolted to cast-iron legs. A drawer is provided for stowing away files and machinists' tools.



Bench equipped with Lathe, Drill Press, Arbor Press, Vise, and Emery-wheel Stand

Two legs at the left-hand end of the bench are stepped down in front to receive the Artisan 11- by 24-inch lathe which was described in March, 1922, MACHINERY. This lathe has a 16-inch gap, and is furnished with a quick-change gearbox which provides for cutting all standard threads from 8 to 224 per inch, and pipe threads of 11 1/2 per inch. The lathe is driven by a friction pulley mounted on a lineshaft which runs in self-aligning bearings in three hangers bolted to the legs.

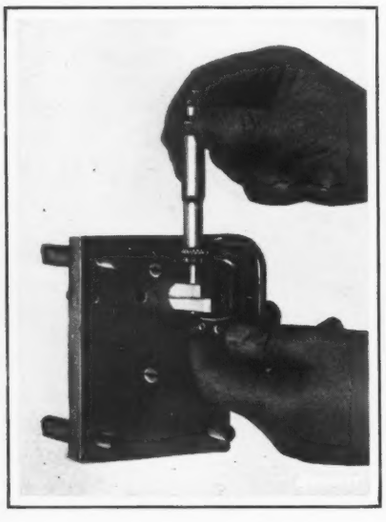
The drill press is bolted to the left-hand end of the bench and controlled through tight and loose pulleys on the lineshaft. A chuck having a maximum capacity for 1/2-inch drills is fitted to the spindle, and this chuck has a No. 2 Morse taper shank that makes it interchangeable in the tailstock spindle of the lathe. The arbor press is bolted to the press at the right-hand end of the lathe; it receives work up to 8 inches in diameter, and has a plunger movement of 8 inches.

The machinist's vise has a swivel base and 3 1/2-inch jaws. Two 6- by 1 1/4-inch wheels, fine and coarse, are fur-

nished on the emery-wheel stand and are driven by a double-flanged pulley on the lineshaft. When not in use, the driving belt hangs slack, but when it is desired to drive the wheels, an idler pulley is brought in contact with the belt to tighten it. The motor is of 1/2 horsepower capacity, and is started and stopped by means of a snap-switch at the left of the drawer. The machinery is mounted along three sides of the bench in such a way that the "Metal-Worker" can be placed against a wall or two of them can be arranged back to back.

BROWN & SHARPE TAPER PARALLEL GAGES

A set of taper parallel gages for use in measuring small holes, blind holes, slots, etc., has been placed on the market by the Brown & Sharpe Mfg. Co., Providence, R. I. These gages are said to be particularly useful in checking holes that are difficult to get at, as in jigs and fixtures, and they can also be used to determine whether or not holes are out of round. The set covers all intermediate plug-gage sizes from 1/4 to 1 inch.



Brown & Sharpe Taper Parallel Gages

From the illustration it will be seen that in checking a hole, two of the gages are fitted snugly into the hole, and then a measurement is taken across them with a micrometer caliper or a vernier caliper to obtain the dimension in thousandths of an inch. The gages are made of tool steel, hardened and ground, and constitute No. 672 in the line of Brown & Sharpe products. The measuring surfaces are ground to a radius to facilitate correct measurements.

WIRE SALVAGING MACHINE

A wire straightening machine, intended for salvaging old wire, has recently been placed on the market by the Kane & Roach Co., Syracuse, N. Y. This machine, it is stated, is able to salvage at least 95 per cent of all the old wire around a plant using wire in its manufacture, no matter how badly twisted the wire may be. The machine consists of eight rolls, the first two of which act as pinching rolls, being equipped with spring adjustment to prevent shaft strain. The other six rolls are staggered, all but one upper roll being driven by gears. These rolls are all made of tool steel, heat-treated and hardened. A feed guide directs the wire into the rolls. The passes in the rolls are so cut that when the machine is once adjusted, it is unnecessary to readjust the rolls for each size of wire, other than to raise or lower the last roll to correct the tendency of the wire to go up or down as it is delivered from the machine. All rolls and gears are covered by guards to protect the operator. The machine has a capacity for 1/16- to 3/8-inch wire, and can handle from 150 to 200 feet of wire a minute. It is connected through reducing gears to a 2-horsepower Westinghouse motor, operating at 1140 revolutions per minute.

* * *

Sheet-metal tops of pure nickel are recommended for tables in chemical laboratories, because few chemicals attack nickel and their action on the metal is very slow.

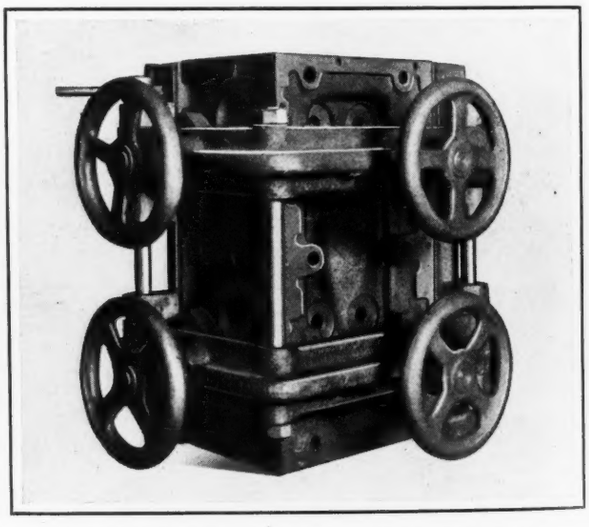
SPECIFICATION FOR WIRE ROPE

The most important paper in its field that has been issued in several years is Circular 208 of the Bureau of Standards, entitled "United States Government Master Specification for Wire Rope," copies of which are now on sale at the office of the Superintendent of Documents, Government Printing Office, Washington, D. C., at 15 cents each. The paper is made up of eight major sections dealing with types, material, and workmanship, general requirements, detailed requirements, inspection and tests, packing and marking, additional information, and general specifications. It contains 28 line drawings and halftones illustrating types of rope, methods of measuring rope diameter, application of seizing, clips, and other fastenings for wire rope. The properties of the different types of rope are set forth in tables which give all the important data in very compact form. This circular has been prepared, after careful study, by the wire-rope committee of the Federal Specifications Board, the chairman of the committee being H. L. Whittemore, of this bureau; and was officially promulgated by the board on June 1, for the use of the departments and independent establishments of the Government in purchasing wire rope.

* * *

TESTING CYLINDER HEADS FOR LEAKAGE

It is the custom at the Sterling Engine Co., Buffalo, N. Y., to give two leakage tests to a certain type of cylinder head built for motor-boat engines. One of these tests is conducted after the roughing operation, and the other when the heads have been completely machined. There are twenty-five holes in one side of this cylinder head that must be covered tightly for the tests, and eight holes in each of two other sides, making a total of forty-one holes that must be covered. For the operation, the head is placed in the fixture shown in the illustration, which is made in halves and hinged at one corner. When a cylinder head has been placed in this fixture, the halves are swung together and locked, and then handwheels are turned to force the side with the twenty-five holes against a rubber gasket large enough to cover all the holes.



Fixture in which Cylinder Heads are enclosed for Leakage Test

Other handwheels are then turned to press gaskets over the remaining holes. With all the holes thus plugged, water under a pressure of 60 pounds per square inch is forced into the head. If a head fails to pass the test, it is scrapped.

* * *

With an output of 2,173,360 cars and trucks during the first six months of 1925, the automobile industry of this country established a new record of manufacture. This total is 5.8 per cent over the corresponding period a year ago, and 5 per cent ahead of the first half of 1923.

FINISHING LARGE QUILL CASTINGS

Two cast-iron quills used in the construction of a certain type of rubber-tire making machine are illustrated in Fig. 1. These quills are turned all over, faced at both ends, and bored to depths of 3 and 4 inches, respectively, in the opposite ends, all in two operations performed in the Warner & Swasey turret lathe shown in Fig. 2. This illustration shows the second operation in process. When the castings are delivered to the turret lathe, the average weight is 330

Fig. 1. Large Cast-iron Quills weighing 250 Pounds Each when finished

pounds, but at the end of the operations, they average 250 pounds. The quills are 25 inches long, 10 and 8 3/4 inches outside diameter at the large and small ends, respectively, and 7 inches inside diameter at both ends. The limits on the bores are plus and minus 0.0005 inch, as large ball bearings are fitted into them. A grinding operation is performed on the outside surfaces subsequent to the turret lathe operations.

In the first operation, the quill is held in a pot chuck with the large-diameter end and part of the small-diameter section overhanging. The large-diameter surface and the overhanging portion of the small-diameter surface are turned, and the end and shoulder faced, by means of tools mounted on the square turret of the machine. At the same time rough-, semi-finish-, and finish-boring cuts are taken on the internal surface at the front end of the casting by tools mounted on the hexagon turret. The small-diameter section is turned for only a short distance in order to facilitate the set-up of the work concentrically in the second operation.

The standard chuck shown on the machine in Fig. 2 is equipped with soft jaws which are bored to fit the finished large-diameter surface of the work. Fastened to the standard chuck is a hollow casting *A*, near the front end of which there are several machine screws positioned radially so that their heads may be adjusted into contact with the work for locating it centrally. In setting up the work, an indicator *B* is applied to the portion of the small-diameter surface previously finished, so as to determine the concentricity of the rotation of the work and permit the proper adjustment of the machine screws. Casting *A* weighs 150 pounds, and is counterbored to fit over the chuck. The first step in the second operation consists of turning the small-diameter portion for the entire length by means of a tool mounted on the square turret, at the same time that the hole of this end is rough-, semi-finish-, and finish-bored. A tool in the square turret is also employed to face the quill to length. Both bores are finished to permit the insertion of the ball bearing shown at *C*.

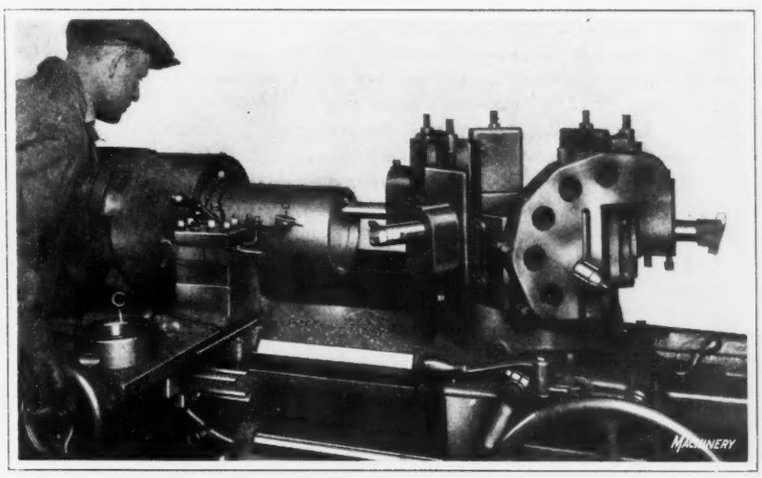


Fig. 2. Arrangement of Turret Lathe for Second Operation on the Quills shown in Fig. 1

The first operation is performed in 2 hours and the second in 1 3/4 hours, which makes a total floor-to-floor time of 3 3/4 hours for the complete job. About 3 hours are required for setting up the machine for the first operation and 2 hours for the second, but as the castings are handled in lots of from 12 to 20, the setting-up times are distributed over a sufficient number of parts to make the operations economical.

* * *

ADDRESS MAIL CAREFULLY

It costs the Post Office Department $1,740,000 annually to maintain the staff at the various post offices in the larger cities whose job it is to find correct addresses for mail matter that is either incorrectly or insufficiently addressed. This is pure waste. If every correspondent would put the street number on every piece of mail going to cities of any size, and make sure that the address is correct, a great deal of this expense could be saved. In this connection, it might be mentioned that a number of firms and individuals apparently take pride in giving no other address but the name of the city in which they are located or live, assuming that they are so well known that no further address is necessary. This practice makes it impossible for a correspondent answering mail to address the reply completely, and the street address often has to be looked up by the special staff engaged for that purpose at our large post offices. Do not be afraid of giving your street address on your letterhead.

Another objectionable method of addressing mail is to give the name of the building rather than the number and name of the street. As the number of buildings with names multiplies, this is an unsatisfactory way of directing mail. Street numbers are much better, and they are easier for the post office.

* * *

SALES EXECUTIVES' CONFERENCE

The third conference of the Sales Executives' Division of the American Management Association will be held at the Hotel Chase, St. Louis, Mo., December 3 and 4, in cooperation with the Sales Managers' Bureau of the St. Louis Chamber of Commerce. W. J. Donald, 20 Vesey St., New York City, is managing director of the American Management Association, and further information may be obtained from him. Among the topics that will be on the program are "Organizing Sales Campaigns for New Products," "Organizing Salesmen's Time," "Fixing the Salesman's Task," and "Branch Office Management."

GLUES FOR USE WITH WOOD

The glues that are adapted for gluing wood, according to a report of the Forest Products Laboratory, U. S. Forest Service, Madison, Wis., may be conveniently divided into five classes as follows:

1. Animal glues, which are made from the hides, hoofs, horns, bones, and fleshings of animals, mostly cattle. These glues come in dry form, and must be mixed with water and melted.

2. Casein glues, which are made from casein, lime, and certain other chemical ingredients. They are commonly sold in prepared form, requiring only the addition of water, but may be mixed by the addition of the separate materials to the water.

3. Vegetable glues, which are made from starch, usually cassava starch, and sold in powdered form. They may be mixed cold with water and alkali, but heat is commonly used in their preparation.

4. Blood-albumin glues, which are made from soluble blood albumin, a product recovered from the blood of animals. These glues must be mixed just before use, since they deteriorate rapidly on standing.

5. Liquid glues, which are commonly made from the heads, skins, bones, and swimming bladders of fish. Some liquid glues are made from animal glue and from other materials. They come in prepared form ready for immediate use.

Animal Glue—Animal glue, frequently referred to as "hot glue," has been in use a long time, and is familiar to all woodworkers. The principal desirable properties of animal glue are its great strength and reliability in the higher grades, its free-flowing consistency, and the fact that it does not stain wood. So far no glue has been found by the woodworking industry to be as suitable as animal glue for hand-spreading on irregular shaped joints, although a cheaper glue would be very desirable. The price of animal glue is the chief factor that limits its use. The fact that it is not highly water-resistant is occasionally a drawback.

Casein Glue—Casein glue has been used commercially for a much shorter time than animal glue, and its possibilities and limitations are not so well known. It has sufficient strength for either veneer or joint work. It is used cold, and when properly mixed it can be spread with a brush. The property most featured is its high water-resistance, which makes it suitable for gluing articles to be used under moist conditions. Not all casein glues are water-resistant, however; there are some on the market which are made to compete with vegetable glue, and for which no great water-resistance is claimed. Among the disadvantages of casein glues are their tendency to stain thin veneer and the relatively short working life of some kinds. It is claimed that this trouble has been overcome to a certain extent in some glues. They are somewhat harder on tools than animal and vegetable glues.

Vegetable Glue—Vegetable glues have found wide use in recent years because they are cheap, can be used cold, and remain in good working condition free from decomposition for many days. They are extremely viscous, and it is not practicable to spread them by hand. Their lack of water-resistance and the fact that they usually cause staining in thin fancy veneer are factors limiting their use. They set relatively slowly, and for this reason are not so well adapted for joint work.

Blood-albumin Glue—Blood-albumin glue has shown notably high resistance to moisture, especially in the boiling test. This makes it particularly suitable for gluing plywood which is later to be softened in hot water and molded. The production of molded plywood articles has been very limited, but it offers a good field for future development. In the past the chief drawback to the use of blood glues has been the necessity for hot-pressing, but tests have shown that a highly water-resistant blood glue may be developed which can be cold-pressed successfully.

Liquid Glue—Liquid glues are, in general, similar in properties to animal glue. Some brands are quite equal in strength to good joint glues, but other brands are very weak and unreliable. Their great advantage is that they come in prepared form, ready for immediate use. This makes them particularly suitable for patch work and small gluing jobs. The factors that limit their use are their high price, their lack of water-resistance, and the difficulty in distinguishing between good and poor brands.

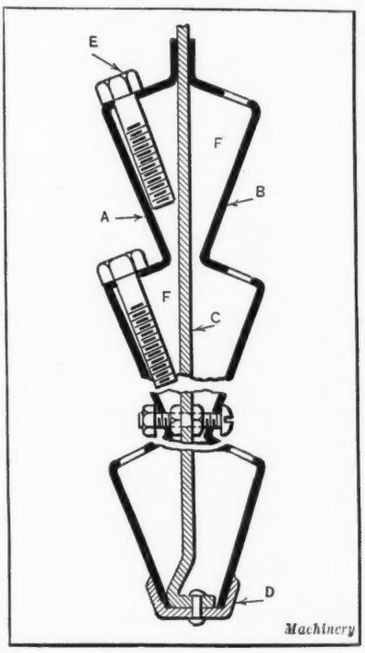
Veneer and Joint Glues—Generally speaking, present vegetable and blood-albumin glues are veneer glues, while animal and casein glues are used both as veneer and as joint glues. As between animal and casein glue for joint work, if freedom from staining is important, animal glue is preferable; if water-resistance is of importance, then a casein glue should be selected. Because of the necessity of heat in the preparation and use of animal glue, the casein cold glue will probably be favored if both glues are otherwise equally well adapted.

* * *

NICKEL-PLATING SCREW-HEADS

The nickel-plating of the heads of screws without depositing sufficient metal on the threads to require rechasing is accomplished in one plant by using a special holder for the work. This holder, a section of which is shown in the accompanying illustration, consists of sheet-copper pieces *A* and *B* secured to a flat piece of brass stock *C*.

The bottom cap *D*, which is riveted to the piece *C*, serves to close the opening at the lower end of the holder. When the holder is filled with screws *E*, the spaces *F* are affected but little by the plating action, and as the threaded ends of the screws project into these shielded spaces, or pockets, not enough nickel is deposited on them to necessitate rechasing the threads. The holder is made long enough to provide for as many holes as there are screws to be nickel-plated at one time. At the end of the holder, there are several holes punched or drilled through the copper, so that the solution can pass into the holder, as otherwise it would float.



Section of Holder used in nickel-plating Screw-heads

* * *

Nine industrial groups of manufacturers, cooperating with the Department of Commerce in simplification and standardization work, estimate that the annual savings due to the simplification of the production and distribution of the products involved, amounts to $293,600,000 annually. Most industrial products are manufactured in too many sizes, styles, and types, and by a reduction in the number of varieties and sizes, through standardization, great savings have been found possible. Among the subjects at present being considered are automotive taper roller bearings, automotive poppet valves, hot-rolled steel in coils, boilers, and accessories, railway shop tools, tacks and nails. The initiative of the Department of Commerce in this field is of the greatest value, and this one activity alone pays a hundredfold for the entire cost of the department.

PERSONALS

JAMES W. SEDERQUIST has entered the employ of the Union Twist Drill Co., Athol, Mass., as a special representative.

JOHN J. CAMPBELL, formerly superintendent of Spang & Co., Butler, Pa., is now connected with the Bessemer Gas Engine Co., of Grove City, Pa.

W. H. FULWEILER, chemical engineer of the United Gas Improvement Co., Philadelphia, Pa., has been elected president of the American Society for Testing Materials.

A. D. MERWIN, formerly connected with the Steele & Johnson Mfg. Co., Waterbury, Conn., is now sales manager of the fabricating division of the Bridgeport Brass Co., Bridgeport, Conn.

W. F. BLYTHE, for nineteen years connected with the American Brass Co., Waterbury, Conn., is now sales manager of the mill products division of the Bridgeport Brass Co., Bridgeport, Conn.

JOHN L. OSGOOD, president of the J. L. Osgood Tool Co., Buffalo, N. Y., recently returned from a tour around the world, during which he visited many of the European countries, and India, China, and Japan.

M. A. WEIDMAYER, formerly branch manager of the Detroit office of the Black & Decker Mfg. Co., is now associated with the United States Electrical Tool Co., Cincinnati, Ohio, in charge of this company's Philadelphia office.

R. T. RICE, Cleveland and Pittsburg representative of the Goddard & Goddard Co., Inc., Detroit, Mich., designers and manufacturers of milling cutters, has moved his office to Room 700, Prospect-Fourth Building, Cleveland, Ohio.

C. H. SCAFFE, formerly connected with the St. Louis office of the Black & Decker Mfg. Co., is now associated with the United States Electrical Tool Co. as special representative, with headquarters at the general office of the company in Cincinnati, Ohio.

CHARLES O. CROMWELL has been appointed Detroit representative of the Hoefer Mfg. Co., Inc., Freeport, Ill. Mr. Cromwell will have offices at 2230 First National Bank Building, Detroit, Mich., and will handle the auxiliary drilling heads made by the Hoefer Mfg. Co.

E. J. FULLAM, secretary and treasurer, and W. F. SLOMER, general sales manager, of the Fellows Gear Shaper Co., Springfield, Vt., returned July 31 from an eight weeks' trip to Europe, where they visited the representatives of the company in England, Belgium, Holland, France, Germany, Switzerland, and Italy.

EARL J. BULLARD, for many years service manager for the Gisholt Machine Co., Madison, Wis., and later connected with the Madison-Kipp Corporation as field engineer, is now production engineer for the W. S. Ray Mfg. Co., San Francisco, Calif., builders of oil burners. His home address is 1312 Palm Drive, Burlingame, Calif.

EDWARD BUSCH, who for several years has been connected with Tate Jones & Co., furnace manufacturers of Pittsburg, Pa., has been appointed district manager of the Hevi-Duty Electric Co., Milwaukee, Wis., for the sale of electric furnaces and equipment in the Ohio and Indiana territory, with offices at 879 Arcade Building, Cleveland, Ohio.

JOSEPH L. SCHOLL, who has been engaged in selling machine tools for many years, and who for the last three years has been with the Reliance Machinery Sales Co., Pittsburg, Pa., is now with the Laughlin-Barney Machinery Co. of the same city. He succeeds J. M. HILL, who recently left the company to enter another line of business in Florida.

W. C. DAVIS, president of Foote Bros. Gear & Machine Co., 232-234 N. Curtis St., Chicago, Ill., recently returned from a Western trip during which he visited the various sales offices of the company located at Denver, Salt Lake City, Los Angeles, San Francisco, Seattle, and Portland. Mr. Davis found excellent conditions prevailing throughout this territory with prospects for a big fall business.

GEORGE A. LENNOX has been appointed assistant general sales manager of the Driver-Harris Co., with headquarters at the main office and plant at Harrison, N. J. Mr. Lennox has been with the company for a number of years, serving in practically all departments. For several years he was district manager in Chicago and later took charge of the company's activities in New England and Northern New York.

PERCY M. BROTHERHOOD, for many years with Manning, Maxwell & Moore of New York, lately as vice-president, has opened an office in the Havemeyer Building, 25 Church St., New York City, and is open for agencies of machine tools and other specialties used by railroad companies. Mr. Brotherhood has a wide acquaintance among railroad officials, especially in what is known as the New York territory, and intends to undertake the agency of comparatively few specialties.

T. D. LYNCH, manager of the material and process engineering department, Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., was elected a member of the board of directors of the American Society for Testing Materials at the recent annual convention of the society in Atlantic City. This is the second similar honor given to Mr. Lynch by engineering bodies, as he was president of the American Society for Steel Treating in 1922-1923. He is a graduate of the University of West Virginia, and has been with the Westinghouse company since 1899.

HAROLD BATES has recently joined the sales department of the Bridgeport Brass Co., Bridgeport, Conn. His work will pertain specifically to sales organization and research. Mr. Bates' early experience was in the public utilities field; later, he entered the industrial field, and for five years he has been with the Winchester Repeating Arms Co., serving successively as sales engineer in charge of the development of new products, superintendent of the sales engineering department, supervisor of sales planning, and in charge of special and jobbing sales of all new products.

HARRY Z. CALLENDER was elected vice-president in charge of sales of the Whitman & Barnes Mfg. Co., Akron, Ohio, manufacturers of twist drills and reamers, at the July meeting of the board of directors. Mr. Callender entered the employ of the company in September, 1895 as an order clerk in the Cincinnati office. Later, he became traveling representative in the Southern states and was on the road in this district for sixteen years. At that time, he was elected to the "Old Guard," an organization famous in the South, having a membership limited to 100, and among other qualifications requiring fifteen years of constructive business traveling in the Southern states. In 1918, he was transferred to Akron where he assisted in the reorganization of the sales department. He has acted as assistant sales manager since August, 1924.

* * *

COMMERCIAL ARBITRATION

More and more the minds of business men are turning to the question of settling industrial disputes out of court, to avoid loss of time, expense, and bad feeling due to litigation. The new Federal Arbitration Act makes it possible to do this and still make the arbitrator's award as binding as a court's decree.

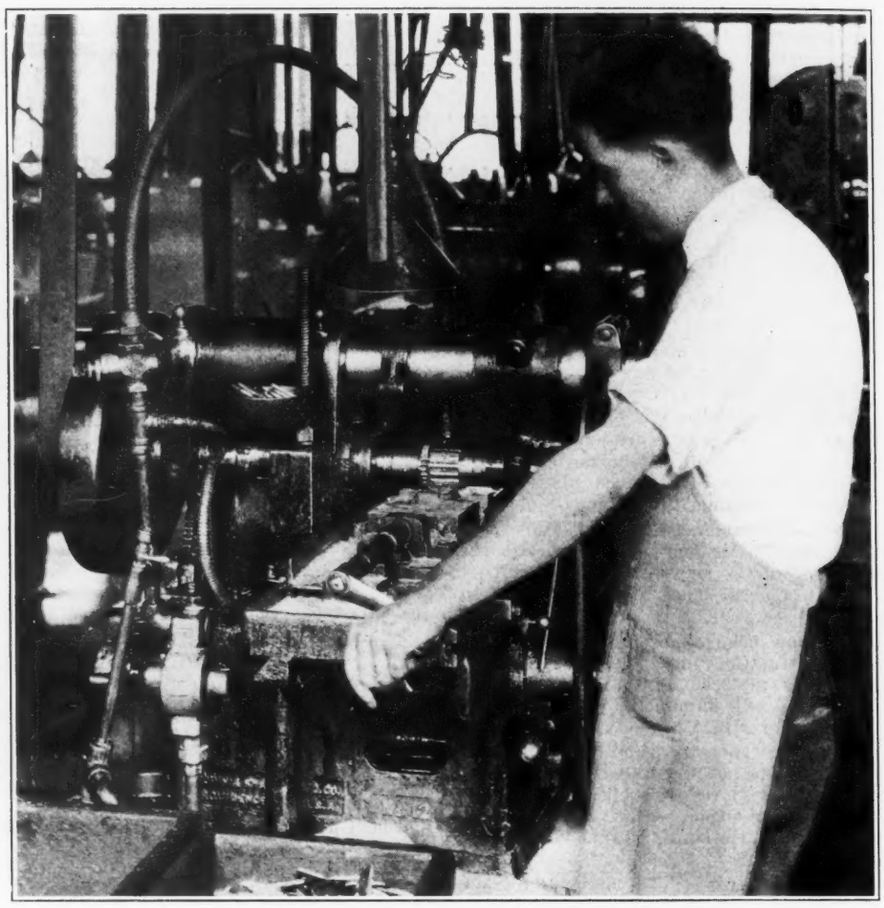
The new Federal Arbitration Act goes into effect January 1, 1926. This law makes enforceable in Federal Courts the awards of arbitrators. Trade associations and chambers of commerce are planning the establishment of arbitration tribunals to help their members settle trade disputes outside of the courts on this basis. The Federal Arbitration Law provides that a written agreement in a contract to submit any controversy under the contract to arbitration is valid, irrevocable and enforceable in the Federal Courts. Thus the authority of the courts is behind the private arbitration action, even though the court may never be called upon to act.

If an arbitration agreement exists, the parties must arbitrate. When the arbitrator renders an award, it must be accepted or the courts will enforce it; but there are certain safeguards to insure justice. The courts may review arbitration awards for fraud or misconduct, and either modify or set aside, but only for certain restricted reasons. The agreement to arbitrate is entirely voluntary, but having agreed upon it, it cannot be disregarded. Only disputes that involve $3000 or more and that arise in interstate commerce are enforceable in the Federal Courts.

The commercial arbitration of industrial disputes, as compared with action in court, saves much of the cost of litigation, cuts down the time of settlements, and permits the settlement by arbitrators who have specific knowledge of the industry or trade affected. Arbitration tends to produce quick justice, dealing strictly with the issue involved. It provides a system of business men's courts "by, for, and of business men."

The accepted form of a contract clause providing for arbitration under the new Federal Law is as follows: "Any and all controversies arising under or out of or in connection with or relating to the agreement of which this is a part shall be submitted to arbitration, and judgment upon any award rendered may be entered in the highest court of the forum, state or federal, having jurisdiction in the premises." This is a general form, which may vary in different states, if there are separate state laws, and with different lines of business. Additional information may be obtained by writing the Arbitration Foundation, Inc., 65 Liberty St., New York City.

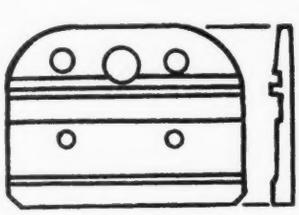
MANUFACTURING TYPE MILLING MACHINES



Stepping up small part production

The above illustration shows a No. 12 Plain (Manufacturing Type) Milling Machine in use for milling small plates. A formed cutter is used, and the piece is milled in one operation as shown in the drawing.

On this and similar jobs one operator can run more than one machine and maintain a steady high production.



Many manufacturers with a small part production problem have found the No. 12 Plain Milling Machine an income producing investment. It is sturdily built, easily set up and is comparatively inexpensive. It is designed throughout for rapid production of small parts, at low cost. The No. 138 Catalog gives complete details.

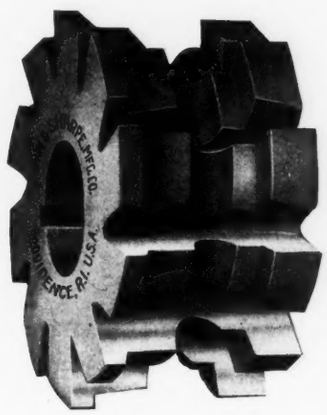
Brown & Sharpe Mfg. Co., Providence, R. I., U. S. A.

If a larger manufacturing type milling machine is required, investigate the Brown & Sharpe No. 13B Plain and the Nos. 21 and 33 Automatic Milling Machines. They are all described in the No. 138 General Catalog. Send for a copy.

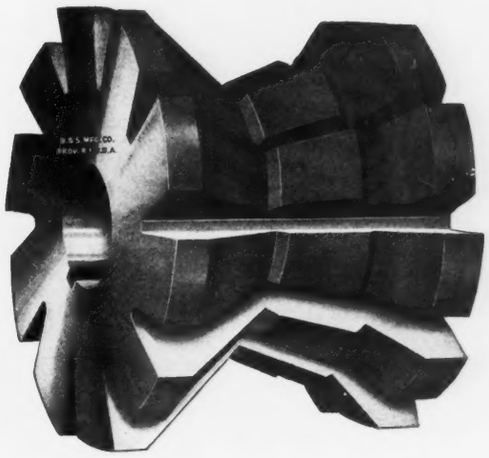
BROWN &

FORMED MILLING CUTTERS

We Will Exhibit
at the
NATIONAL STEEL EXPOSITION
Public Auditorium, Cleveland, O.
Sept. 14-18
Booth Nos. 234-235



The Outline is Insured!



Insuring an accurate outline

In the making of Brown & Sharpe Formed Milling Cutters, particular attention is paid to the relieving of the form. As a result, the original accuracy of the outline produced is maintained as the cutters are repeatedly sharpened.

These cutters are made from the finest steels obtainable. A precise balance of tenacity and hardness is attained by careful heat-treatment, assuring long service.

The Brown & Sharpe Cutter Department is prepared by a long cutter-making experience to meet your requirements exactly.

Specify Brown & Sharpe Formed Milling Cutters for *insured* accuracy of outline.

The No. 138 Catalog lists our complete line of Cutters as well as Machines and Small Tools. A copy will be mailed to you at your request.

& SHARPE

TRADE NOTES

KUHLMAN ELECTRIC CO., Bay City, Michigan, has appointed the Stevens Sales Co. of 134 West Second South Street, Salt Lake City, Utah, as district representative for the state of Utah and parts of Idaho and Nevada, adjacent to Utah.

UNION MFG. CO., New Britain, Conn., manufacturer of lathe, drill, and planer chucks, announces that the Machinists' Supply Co., Pittsburg, Pa., has been appointed sole distributor of the company's complete line of chucks for the Pittsburg district.

UEHLING INSTRUMENT CO., Paterson, N. J., has appointed as its representatives in two southern territories, John C. Candler, 315 Glenn Bldg., Atlanta, Ga., and Charles M. Setzer, Charlotte, N. C., who will handle the company's line of power plant instruments.

GIBB WELDING MACHINES CO., (successor to Gibb Instrument Co.), Bay City, Michigan, manufacturer of electric welding equipment, announces the appointment of Arthur Jackson, 32 Glenholme Ave., Toronto, Ontario, as sales representative for Ontario and Eastern Canada.

AMERICAN BROACH & MACHINE CO., Ann Arbor, Mich., manufacturer of broaching machines and broaching tools, announces that the Cleveland Duplex Machinery Co., Inc., Cleveland, Ohio, will represent the company in the future in Cleveland and the surrounding territory.

BRIDGEPORT BRASS CO., Bridgeport, Conn., announces that it will distribute free, for convention purposes, a neat brass tack pin to those associations whose members use products similar to those made by the company. This includes practically all of the associations in the mechanical field.

LINDE AIR PRODUCTS CO., 30 E. 42nd St., New York City, manufacturer and distributor of oxygen for welding and cutting, announces that its district sales office at Seattle is now located at 421 Railway Exchange Building, 619 Second Ave., Seattle, Wash. O. H. Davenport is district sales manager.

SPAULDING FIBRE CO., INC., Tonawanda, N. Y., has recently opened branches at Detroit, Mich., Cleveland and Cincinnati, Ohio, with ample warehouse space for carrying all standard forms of Spaulding fiber, as well as sheets, rods and tubes. Each branch is equipped with fabricating facilities to expedite the filling of orders with the least possible delay.

DENNISON ALLOY & STEEL CASTING CO., Dennison, Ohio, has purchased the patent rights and holdings of the MARTIN TRACTOR SHOVEL CO., Greensburg, Pa. The Dennison company has re-equipped its plant for the manufacture of the Martin tractor shovel, and will begin operation on that product within the next two months, with D. S. Jones as manager.

HAYNES STELLITE CO., Kokomo, Ind., manufacturer of metal-cutting tools and other articles of high-speed, rust- and corrosion-resisting alloys, announces that all the company's activities in the future will be conducted from its plant at Kokomo, Ind. The administration headquarters and the sales and engineering offices will be located there. C. G. Chisholm is general manager.

BANTAM BALL BEARING CO., Bantam, Conn., in view of a rumor that has been circulated, announces that there has been no change in the management of the company and that those who have guided its policies for years are still conducting its affairs. The company's manufacturing facilities have been greatly increased, for the making of both ball thrust bearings and journal roller bearings.

W. A. JONES FOUNDRY & MACHINE CO., 4409 W. Roosevelt Road, Chicago, Ill., announces that its office in Minneapolis, Minn., will be located at 614 Builders Exchange, with F. S. Van Bergen in charge as district sales manager. This office will cover all of Minnesota, North and South Dakota, and also parts of Iowa and Wisconsin that are adjacent to Minnesota. The company's entire line of speed reducers, clutches, gears, pulleys, couplings, and power transmission equipment specialties will be handled from this office.

FORD CHAIN BLOCK CO., 2nd and Diamond Sts., Philadelphia, Pa., announces that it has acquired all patents, designs and equipment for the manufacture of the Motorbloc, an electrically operated chain hoist which has been manufactured for several years by the Motorbloc Corporation of Philadelphia. Beginning September 1, this line of hoists will be built in the plant of the Ford Chain Block Co. and sold as this company's product. The acquisition of this line makes it possible for the company to offer a complete line of chain hoists in both hand and motor operated types.

LANDIS MACHINE CO., Victor Plant, Waynesboro, Pa., manufacturer of Victor collapsible taps, solid adjustable taps, and receding chaser taps, has made arrangements with the following agents to handle the company's products: Chadwick Co., 549 W. Washington Blvd., Chicago, Ill., for the states of Illinois, Wisconsin, Iowa, and northern Indiana; A. J. Vaughn, Machinery Expedition and Sales Department, Bourse, Philadelphia, Pa., for eastern Pennsylvania, New Jersey, and Delaware; and William H. Harvey, 225 Denison Bldg., Syracuse, N. Y., for Syracuse, Rochester, and central New York.

AIR REDUCTION SALES CO., 342 Madison Ave., New York City, manufacturer of oxygen and acetylene, carbide, and welding and cutting apparatus, announces that it has purchased the GAS TANK RECHARGING CO., which owned and operated acetylene plants at Milwaukee, Wis., and Bettendorf, Iowa, and a carbide plant at Keokuk, Iowa. The Air Reduction Sales Co. has twenty-six oxygen plants, fifteen acetylene plants, fourteen apparatus repair stations, two carbide plants, two calorene plants, and an apparatus factory, together with experimental laboratories. The products of these plants are distributed nationally through 148 distributing stations.

CINCINNATI SHAPER CO., Elam St. and Garrard Ave., Cincinnati, Ohio, announces the following agency arrangements: The Huey & Philp Hardware Co. of Dallas, Tex., has been appointed exclusive representative of the Cincinnati Shaper Co. and the Cincinnati Gear Cutting Machine Co. for the sale of their machines in Central and West Texas; Woodward-Wight & Co., Ltd., New Orleans, La., has been appointed exclusive representative of these companies in the New Orleans territory; the sale of Cincinnnati all-steel press brakes manufactured by the Cincinnati Shaper Co. will be handled in the Chicago territory by Neff Kohlbusch & Bissell, 1045 W. Washington Blvd., Chicago.

PITTS FOUNDRY CO., INC., 54th St. and 1st Ave., Birmingham, Ala., has been organized, with Alton V. Pitts, who for the past seven years has been general superintendent of the Kent Machine Co., Kent, Ohio, as president and treasurer. G. Johnson, formerly with the Miller Improved Gas Engine Co., of Springfield, Ohio, is vice-president and superintendent; and A. Wynn Jones, practicing attorney of Birmingham, Ala., secretary. The company has leased and operates the foundry and pattern shop formerly occupied by the American-Blakeslee Mfg. Co., having a melting capacity of twenty tons a day. The new company specializes on quality gray iron castings up to 4000 pounds in weight.

PRATT & WHITNEY AIRCRAFT CO. is the name of a new concern that has applied for incorporation papers under the laws of the State of Delaware to engage in the development and manufacture of aeronautical engines. The company will occupy the part of the manufacturing facilities of the Pratt & Whitney Co., Hartford, Conn., that was formerly the Pope-Hartford Motor Plant, and will be jointly owned by the Pratt & Whitney Co., other important manufacturing interests, and men experienced in the aeronautical industry. Fred B. Rentschler is president, George J. Mead, vice-president, and E. L. Morgan, secretary and treasurer. Mr. Mead will direct the engineering work of the new company, having had an extensive experience in this field. Hartford was determined upon for the location due to the favorable manufacturing conditions and its reputation for high grade mechanics with experience in precision work.

* * *

WAGES OF SKILLED MEN

A comparison of wages in different countries before the war and in December, 1924, together with a comparison of the actual purchasing power of these wages is published in a recent issue of *Engineering*. In this comparison, 100 is taken as an indication of the purchasing power of wages in Great Britain. On this basis, it is found that in pre-war years the purchasing power of the wages of skilled labor in the United States was 31.5 per cent higher than in Great Britain, while the purchasing power of the wages of skilled labor in Germany, France, and Belgium was from 37 to 45 per cent less than that of the British workman's wages. In December, 1924, the purchasing power of the wages of skilled men in the United States was 120 per cent higher than in Great Britain, and the purchasing power of wages in France, Belgium, and Germany from 5 to 27 per cent below that of British wages. From a comparison of these figures, says *Engineering*, it will be seen that the skilled labor of the United States has enormously improved its position relative to the European countries since 1914.

* * *

The freight traffic during the first six months of the year made a new record, exceeding the first half of 1923 by 1.2 per cent.

Announcing THE NEW CINCINNATI PYRAMID COLUMN MILLERS WITH TAPERED ROLLER BEARINGS

No. 3 Plain High Power Pyramid Column Cincinnati Miller

SIZES

PLAIN

1M—2M—2 High Power
—3 Std—3 High Power

UNIVERSAL

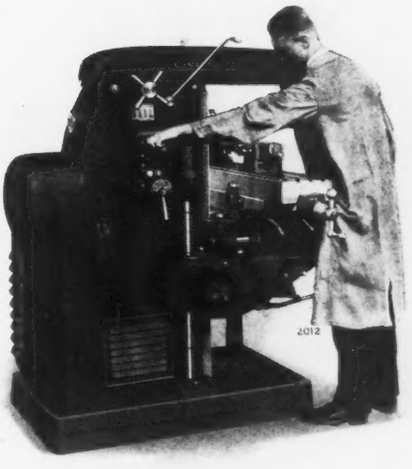
1M—2M—2 High Power
—3 Std—3 High Power

VERTICAL

1M—2M—3 High Power

Look these Productive Features over—

1. Tapered Roller Bearings for Speed Mechanism.
2. Automatic Oiling in Column.
3. Centralized oiling for knee, saddle and table.
4. Pyramid Column.
5. Enclosed motor drive (machine can be arranged also for overhead belt drive.)
6. Power Rapid Traverse.
7. Rear Control.
8. Sliding Gear Transmission.
9. Multiple disc Clutch running in Oil.
10. Double Starting Levers.
11. Rectangular Overarm.



Operator changing speeds from front of machine of new No. 2-M Plain Pyramid Column Cincinnati Miller.

THE CINCINNATI MILLING MACHINE CO.
CINCINNATI, OHIO

CINCINNATI MILLERS

MEETING OF RAILWAY SHOP FOREMEN

The American Railway Tool Foremen's Association will hold its thirteenth annual convention at the Hotel Sherman, Chicago, September 2 to 4. This association is composed of machine shop and tool foremen who have adopted for their motto "Higher Efficiency in the Railway Tool Service." The president of the association is Charles Helm and the secretary is G. G. Macina, of the Chicago, Milwaukee & St. Paul Railway. An unusual and interesting program has been arranged, which should prove of great value to the foremen attending. The opening address will be made by H. T. Bentley, General Superintendent of Motive Power of the Chicago & Northwestern Railroad. G. T. Martin, Assistant to General Superintendent of Motive Power of the Chicago, Milwaukee & St. Paul Railway, will talk on "The Tool Foremen's Responsibilities," and E. L. Woodward, Associate Editor of the *Railroad Mechanical Engineer* will talk on "The Importance of the Tool-room to the Railroads."

Papers have been prepared by various committees on the following topics, which should bring forth considerable discussion and help to promote efficiency and economy in the tool service. "Standardization of Tools in the Locomotive and Car Shops"; "Grinding in the Railroad Shops"; "Jigs and Devices for the Locomotive and Car Shops"; "Forging Machine Dies"; "Machine Tool Equipment for the Tool-room"; and "Economies Possible by Standardized Small Tools". Exhibits of modern machine and hand tools will be displayed by the Railway Supply Association, of which C. O. Montague is president and H. K. Clark, secretary-treasurer.

* * *

INDUSTRIAL ENGINEERING COURSE

A number of engineering colleges have established industrial engineering courses within recent years. The Ohio State University now announces that this fall a department of industrial engineering will be connected with the College of Engineering of this university. John Younger, formerly chief engineer of the truck division of the Pierce-Arrow Motor Car Co., chief of the engineering division of the Motor Transport Corporation, and vice-president of the Standard Parts Co., will head the department. Problems of factory location and lay-out, the grouping of tools and processes, time study, and the study of the design of proper fixtures will be matters that will be dealt with.

MEETING OF AMERICAN WELDING SOCIETY

The American Welding Society will hold its fall meeting at the Massachusetts Institute of Technology, Cambridge, Mass., October 21, 22, and 23. In connection with the meeting there will be exhibits of welded products and actual demonstrations of welding and cutting. The object of these exhibits is to show industrial managers and engineers the possibilities of welding. The demonstrations will start at 9 a. m. each day and be continued until 5 p. m.

Five technical sessions are planned on subjects of interest to welding engineers. Among the papers to be read are the following: "Thermit Welding," by J. H. Deppeler, chief engineer, Metal and Thermit Corporation; "Industrial Applications of Arc Welding and Economies Effected Through Its Use," by H. M. Hobart, chairman, and W. Spraragen, secretary of the Electric Arc Welding Committee; and "Spot Welding of Automobile Bodies," by J. W. Meadowcroft, general supervisor of welding, E. J. Budd Mfg. Co. In addition there will be an address on "Gas Welding of Power Plant Piping," and a series of brief addresses by several authors on "Selection of Materials for Welding."

A meeting of the research department of the society—known as the American Bureau of Welding—will be held Thursday afternoon, October 22. At this meeting, present research activities will be reviewed and the program for future investigations will be outlined.

* * *

STANDARDIZATION OF DRAWINGS ABROAD

The example set by Germany and other Central European countries in standardizing drawings and drafting-room practices is being followed by the Italian Standards Committee as evidenced by its latest Progress Report, in which the following projects on the standardization of technical drawings are shown: Standard sizes of sheets, standard lettering, types and thicknesses of lines, position of views, conventional representation of machine elements (screws, bolts, gears, etc.), dimensioning, and conventional notations for structural drawings. The American Engineering Standards Committee has collected a great deal of information on this subject, of foreign and domestic origin. It has been proposed that standardization on this project should be undertaken under the auspices of the American Engineering Standards Committee, and the committee has authorized the calling of a conference to decide on the advisability of the work.

COMING EVENTS

SEPTEMBER 2-4—Thirteenth annual convention of the American Railway Tool Foremen's Association at Hotel Sherman, Chicago, Ill. Secretary-treasurer, G. G. Macina, 11402 Calumet Ave., Chicago, Ill.

SEPTEMBER 8-11—Machine Tool Exhibition in the Mason Laboratory, Sheffield Scientific School, Yale University, New Haven, Conn. H. R. Westcott, chairman, 400 Temple St., New Haven, Conn.

SEPTEMBER 14-18—Annual convention of the American Society for Steel Treating, and Seventh National Steel Exposition, to be held at the Public Auditorium, Cleveland, Ohio. Secretary, W. H. Eisenman, 4600 Prospect Ave., Cleveland, Ohio.

SEPTEMBER 14-19—Radio Fair to be held at the 258th Field Artillery Armory, New York City. For further information write Calvin Harris, Hotel San Remo, New York City.

SEPTEMBER 15-16—Production meeting of the Society of Automotive Engineers at Cleveland, Ohio. Secretary, Coker F. Clarkson, 29 W. 39th St., New York City.

SEPTEMBER 28–OCTOBER 3—Tenth exposition of chemical industries at Grand Central Palace, New York City.

OCTOBER 5-9—Annual convention of the American Foundrymen's Association at Syracuse, N. Y. An exhibition of foundry and machine shop equipment and supplies will be held in connection with the convention.

OCTOBER 21-23—Fall meeting and exhibit of the American Welding Society at the Massachusetts Institute of Technology, Cambridge, Mass. M. M. Kelly, 33 W. 39th St., New York City, secretary.

NOVEMBER 30–DECEMBER 4 — Annual meeting of the American Society of Mechanical Engineers at the Engineering Societies Building, 29 W. 39th St., New York City. Calvin W. Rice, secretary.

NOVEMBER 30—DECEMBER 5—Fourth national exposition of power and mechanical engineering to be held in the Grand Central Palace, New York City.

JANUARY 11-13—Second World Motor Transport Congress to be held in New York City during the National Automobile Show. Sponsored by the National Automobile Chamber of Commerce, 366 Madison Ave., New York City.

NEW BOOKS AND PAMPHLETS

TECHNICAL VOCABULARY IN ENGLISH, PORTUGUESE AND FRENCH. 216 pages, 5 by 7 inches. Published by F. de Carvalho Henriquès, Apartado 145, Lisbon, Portugal. Price, $1.50.

TOOL STEEL. Joseph T. Ryerson & Son, Inc., Chicago, Ill. "Shop Handbook on Tool Steel," a treatise of 80 pages, 4½ by 7½ inches, dealing with a technical subject in a non-technical way, for the purchasing agent, the superintendent, and the toolmaker.

This book has been prepared by G. Van Dyke, manager of the special steel department of Joseph T. Ryerson & Son, Inc., and contains chapters on Choosing the Proper Steel for the Job, the Heat-treatment of Tool Steel, Ryolite Tool Steel, and Tables and General Information.

STEAM, HOT WATER, AND VAPOR HEATING AND VENTILATION. By Alfred G. King. 551 pages, 6 by 9 inches; 396 illustrations. Published by the Norman W. Henley Publishing Co., 2 W. 45th St., New York City. Price, $4.

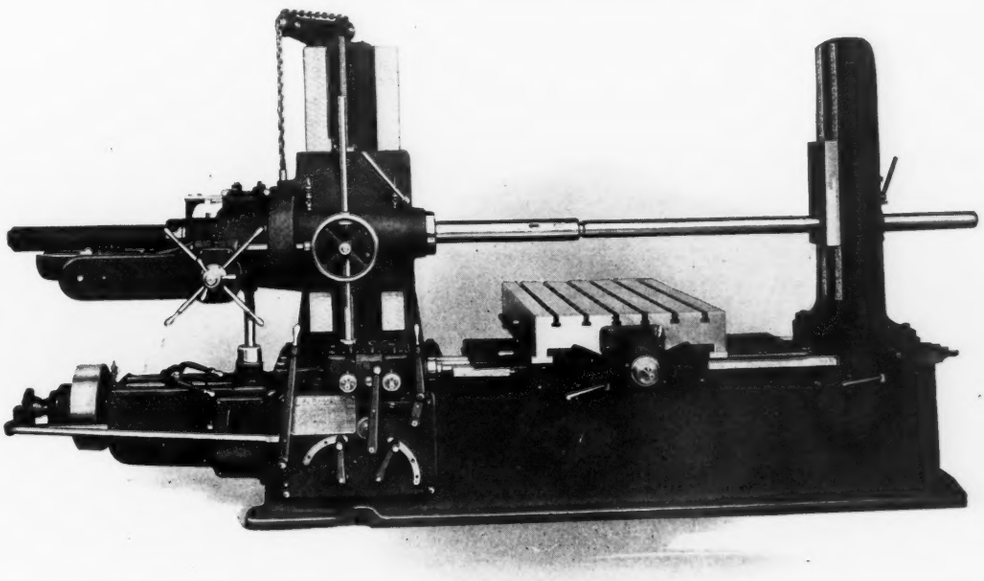
This is the fifth revised and enlarged edition of the author's work on heating and ventilation. The book covers a wide range of subjects, dealing first with heat and the physical laws governing its transmission and radiation. This is followed by a review of the evolution of artificial heating apparatus, boilers, chimneys, fuels and combustion, pipes and fittings, valves, and radiators. A number of different chapters are then devoted to steam heating, hot water heating, modified heating systems, and mechanical ventilation.

The purchase of a high grade machine tool is an INVESTMENT—not an expense. It should be considered as a means to an end.

The SAVINGS in reduced cost of machining and fitting your work for assembly will, in a surprisingly short time, WRITE OFF the cost of the

"PRECISION"

Horizontal Boring, Drilling and MILLING MACHINE



Visit our Exhibit, Space 242, National Steel Exposition, Cleveland, September 14-18. Then call at our shop at 523 East 99th St., reached via St. Clair street car.

WE ALSO MAKE THE

LUCAS POWER Forcing Press

THE LUCAS MACHINE TOOL CO. NOW AND ALWAYS OF CLEVELAND, OHIO, U.S.A.

FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry. Societe Anonyme Belge, Alfred Herbert, Brussels. Allied Machinery Co., Turin, Barcelona, Zurich. V. Lowener, Copenhagen, Christiania, Stockholm. R. S. Stokvis & Zonen, Paris and Rotterdam. Andrews & George Co., Tokyo.

MODERN GAGING PRACTICE. By Albert A. Dowd and Frank W. Curtis. 280 pages, 6 by 9 inches, 165 illustrations. Published by the Engineering Magazine Co., New York City. Price, $3.00.

In this work the authors have endeavored to present the subject of gaging as related to interchangeable manufacturing in such a way that it may be understood by the rank and file of those engaged in mechanical work and to whom a knowledge of the subject is necessary. Highly technical descriptions have been avoided as far as possible, in order to present the data clearly to men not specifically engineers. The book is divided into eleven chapters headed as follows: Interchangeable Manufacture, The Limit System, Standard and Reference Gages, Work Gages, Inspection Gages, Gaging of Screw Threads, Inspection of Gaging of Gears, Manufacture and Care of Gages, Organization and Management of Inspection Department, Final Testing, and Discussion of Tolerances.

NEW CATALOGUES AND CIRCULARS

TURRET LATHES. Foster Machine Co., Elkhart, Ind. Photographs, blueprints and description covering the production of tractor parts on turret lathes.

GEARS. Charles Bond Co., 617 Arch St., Philadelphia, Pa. Catalogue No. 42 of standard stock gears, covering spur, bevel, miter, internal, worm and spiral gears.

MILLING MACHINES. Kearney & Trecker Corporation, Milwaukee, Wis. Leaflet illustrating and describing a special milling operation on Le Roi motor oil-pans.

MILLING MACHINES. Ingersoll Milling Machine Co., Rockford, Ill. Circular illustrating and describing the Ingersoll circular continuous milling machines for high production.

MOTOR CONTROL. Monitor Controller Co., 500 E. Lombard St., Baltimore, Md. Folder illustrating and describing electric control and service switch for starting lineshaft motors.

ELECTRIC HOISTS. Roeper Crane & Hoist Works, Inc., 1740 N. Tenth St., Reading, Pa. Circular No. 118, illustrating and describing the design of Roeper Type R hoists and showing typical installations.

BALL BEARINGS. New Departure Mfg. Co., Bristol, Conn. Bulletin No. 167FE, illustrating and describing ball bearings applied to chaser grinder spindle and to double spindle buffing and polishing lathe.

PIPE BENDERS. Pedrick Tool & Machine Co., 3639 N. Lawrence St., Philadelphia, Pa. Folder illustrating and describing the Pedrick horizontal pipe bender and the Pedrick power-driven pipe bender.

THREADING TAPS. Pratt & Whitney Co., Hartford, Conn. Circular 318, illustrating and describing ground thread taps and thread hobs, and giving performance records of these tools, together with price lists, dimensions, and commercial tolerances.

ELECTRIC WELDING. American Electric Fusion Corporation, 2610-2620 Diversey Ave., Chicago, Ill. First issue of a publication entitled "A. E. F. Welding Illustrated," containing an article on the principles of electric spot, butt, and seam welding.

BELT CONTACTOR. T. B. Wood's Sons Co., Chambersburg, Pa. Bulletin 268, illustrating and describing the U. G. automatic belt contactor, which automatically wraps the belt around its pulley, thereby increasing the arc of contact as the load increases.

TURBINE BLOWERS. L. J. Wing Mfg. Co., 352-362 W. 13th St., New York City. Bulletin 77, illustrating and describing turbine blowers. The bulletin also gives information relative to the application of these blowers to stokers, and graphical representation of their use for hand-fired boilers.

SHOP DUMB-WAITERS. Warner Elevator Mfg. Co., Cincinnati, Ohio. Circular illustrating and describing type F-18 electric dumb-waiter, suitable for all uses where dumb-waiters are required, including messenger service between floors in shop and office buildings.

EXHAUST FANS. American Blower Co., Detroit, Mich. Bulletin No. 3506, illustrating and describing "ABC" steel plate exhaust fans, Type E. A very complete set of tables compiled from tests made in accordance with the provisions of the standard code for exhaust fans is included.

ROLLER BEARINGS. Timken Roller Bearing Co., Canton, Ohio. Loose-leaf binder containing information relating to roller bearings, including bearing recommendations for industrial applications, speed-capacity curve, and tables giving radial and thrust capacities of different sizes of roller bearings.

GEAR GRINDING MACHINES. Garrison Gear Grinder Co., Dayton, Ohio. Catalogue illustrating and describing the Garrison gear grinding machine, calling attention to the principles involved and the special features embodied in the process. Gear testing and inspection devices are also illustrated and described.

CHUCKS. Westcott Chuck Co., Oneida, N. Y. Catalogue No. 520, revised up to June 1925, illustrating and describing the Westcott line of lathe and drill chucks. Lathe chucks of the combination, independent, and universal types are shown, as well as auxiliary screw cutting-off chucks, two-jawed chucks, and drill chucks.

OXY-ACETYLENE WELDING. Oxweld Acetylene Co., Chicago, Ill. Booklet entitled "Precautions and Safe Practices," containing directions for the safe storage, care and handling of acetylene and oxygen cylinders; for the setting up of welding and cutting apparatus; and for the general operation of oxy-acetylene equipment.

SHOP HEATING. American Blower Co., Detroit, Mich. Catalogue entitled "The Venturafin Method of Heating," illustrating and describing a heating method for which great efficiency and numerous other advantages are claimed. Also catalogue of electrically driven fans and blowers for exhausting, blowing, ventilating, drying, and cooling.

LATHES. Niles-Bement-Pond Co., 111 Broadway, New York City. Circular 316, entitled "Time-saver Lathes," covering the 27-, 30-, and 36-inch sizes of lathes built by the company. The circular contains halftone engravings and line illustrations of the detail construction of these lathes, together with complete descriptions and general dimensions.

OXY-ACETYLENE PROCESS. Air Reduction Sales Co., 342 Madison Ave., New York City. Booklet entitled "Answers to Questions about the Oxy-acetylene Process," containing a brief review of the principles and history of the process and information relating to oxygen, oxygen cylinders, acetylene, acetylene cylinders, oxy-acetylene equipment, and welding and cutting.

PORTABLE AND STATIONARY ELEVATORS. New Jersey Foundry & Machine Co., 90 West St., New York City. Catalogue No. 106, entitled "Delta Portable and Stationary Elevators," containing illustrations and descriptions of the various types of elevators built by this company, together with illustrations of applications and installations in industrial plants.

STAINLESS STEEL. American Stainless Steel Co., Commonwealth Bldg., Pittsburgh, Pa. Publication entitled "Stainless in Industry," devoted to the possibilities of stainless iron and steel, and pointing out the advantages of this material when a combination of mechanical strength, ductility, and resistance to corrosion, tarnish, effect of high temperatures, erosion, or abrasion is required.

DIE-SETS. Danly Machine Specialties, Inc., 4911 Lincoln Ave., Chicago, Ill. Catalogue illustrating and describing by halftones and line engravings different types of die-sets made by the company, giving complete dimensions. Four new types of die-sets have been added in the new catalogue, bringing the total up to twelve types and ninety-seven distinct sizes. The catalogue also describes a number of new devices recently brought out by the company.

WELDING AND CUTTING EQUIPMENT. Smith's Inventions Inc., Minneapolis, Minn., the eastern branch of which is located at 1526 Race St., Philadelphia, Pa. Catalogue No. 6, illustrating and describing welding and cutting equipment, and including the latest changes and additions made in this line of apparatus. The catalogue covers welding and cutting outfits, acetylene generator plants, welding torches, cutting torches, preheating torches, and auxiliary equipment.

ENGRAVING MACHINES. George Gorton Machine Co., Racine, Wis. Catalogue 933, of Gorton patent engraving machines. This is a most complete and comprehensive catalogue, comprising 237 pages, 10 by 13 inches, containing concise illustrated descriptions of all the types of engraving machines built by this company, together with complete data relating to tools and equipment that would be of value to users or prospective buyers of engraving machines. The machines described engrave lettering, or other designs, sunk or in relief, copying them from enlarged models.

BALL BEARINGS. Norma-Hoffmann Bearings Corporation, Stamford, Conn. Catalogue entitled "Norma Precision Ball Bearings, Open and Closed Types," illustrating and describing the products of the company and giving tabulated information relating to sizes and dimensions. Also catalogue entitled "Hoffmann Precision Roller Bearings for Heavy Loads and Hard Service," illustrating and describing this type of bearing, giving complete information about the bearings themselves and their lubrication and mounting.

ELECTRIC CONTROLLERS. Electric Controller & Mfg. Co., Cleveland, Ohio. Bulletin 1016-B, on automatic motor starters for non-reversing direct current motors; Bulletin 1024-A, on solenoids for direct current; Bulletin 1033-B, on automatic pressure regulators and cushion tanks for alternating and direct current; Bulletin 1048, on starting switches for small A. C. motors; Bulletin 1042-E, on automatic compensators for A. C. squirrel-cage motors; and Bulletin 1040-B on safety limit stop for direct current motors.

ELECTRICAL SUPPLIES. Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Catalogue 1925-1927 covering electrical supplies. This catalogue contains a complete presentation of the apparatus manufactured by the Westinghouse Electric & Mfg. Co., or obtainable through its district offices and agent jobbers, giving detailed information concerning all equipment. The publication contains 1200 pages, is illustrated with 4500 engravings, and lists of new apparatus designed and manufactured in the past two years, as well as all previously established types. The catalog is conveniently thumb-indexed for ready reference.

ELECTRIC WELDING. Lincoln Electric Co., Cleveland, Ohio. Instruction manual entitled "Lincoln 'Stable Arc' Welder." This book explains the methods used for the installation and maintenance of the Lincoln "Stable Arc" welding equipment in a series of nine lessons in arc welding, covering also the methods of procedure for standard operations. A preface is provided, directing how the manual may be studied to best advantage. This is followed by instructions for uncrating new equipment, locating it to best advantage, wiring, maintenance, and general methods. Then follow the nine lessons pertaining to different phases of electric arc welding.